APRIL 1958 • ONE DOLLAR

A McGRAW-HILL PUBLICATION

Worried about FLOODS? see p 109

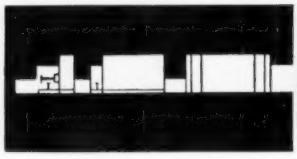
Power

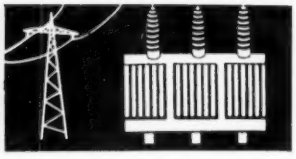
For engineers who design and manage the power and plant services

a *TD* report:

Electric cables swing to new materials p 73

75 years AEG



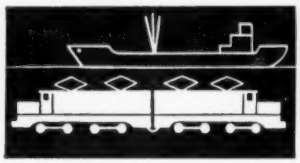


The trade mark "AEG", the significant abbreviation of

"Allgemeine Elektricitäts-Gesellschaft",

is today one of the best known signs of quality in the electrical engineering field.

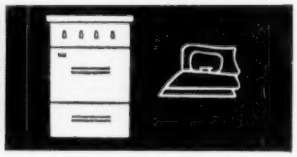
The AEG was founded 75 years ago under the title "Deutsche Edison-Gesellschaft". At all stages of its development, from the modest beginning on April 19, 1883 to the present giant undertaking, growth was supported by a chain of important contributions to electrical engineering science. Our production programme ranges from the smallest domestic appliance to the largest power station and is handled in 18 modern factories and numerous planning departments.



From the very start the company has fostered relations with other countries. Today there are representatives or distributors in nearly every country of the world.

75 years of endeavour have endowed us with an immense sum total of experience. This experience guarantees a high quality of production at all times and forms a sound basis for further progress. AEG products are known and esteemed everywhere.

The 75 years of AEG history put us under an obligation to continue rendering faithful service to our millions of home and overseas customers.



AEG

8209 e

ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT

Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

How Link-Belt's big-plant background boosts efficiency in small boiler houses

LINK-BELT HANDLING SYSTEM keeps powerhouse boilers supplied at Dunlop Canada Limited tire and foam rubber plants, Whitby, Ontario. Bucket elevator transfers coal from track hopper to storage or to drag chain conveyor leading into powerhouse.

Link-Belt installations are developed from industry's most extensive coal handling experience

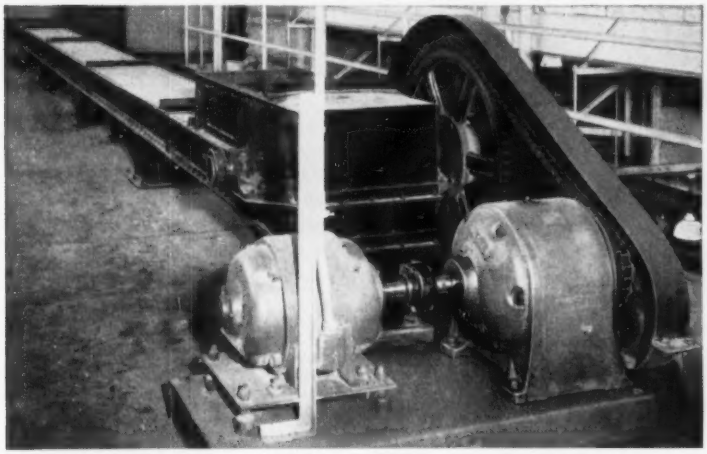
With engineering and equipment proved in some of the largest power plants in the country, as well as in smaller industrial boiler houses, Link-Belt can assure lowest possible per-ton handling costs wherever coal is a source of power . . . whether capacity is one ton or thousands of tons per hour.

Conveyors, elevators, feeders, screens, skip hoists, hoppers, chutes, gates, stackers, car unloaders and shakers, unloading towers, weigh larries and related equipment—all are available from Link-Belt—*the most complete line* in the field. And with this equipment, Link-Belt can give you a smooth functioning coal handling system that exactly matches your capacity and layout requirements. We will work with your engineers and consultants from planning through erection, if desired.

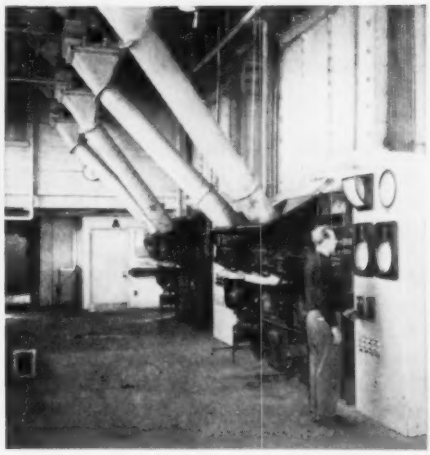
For complete details, call your nearest Link-Belt office. Or write for Book 2410. It shows the latest layouts and equipment for power plants, large and small.

LINK-BELT

COAL HANDLING EQUIPMENT



SMOOTH DISTRIBUTION — Link-Belt drag chain conveyor receives coal from bucket elevator and discharges it to Dunlop powerhouse bunkers. Conveyor's drive includes Link-Belt roller chain and helical gear speed reducer.



COAL BUNKERS are equipped with Link-Belt cast iron duplex gates which are operated by chain and wheel controls on extended shafts.

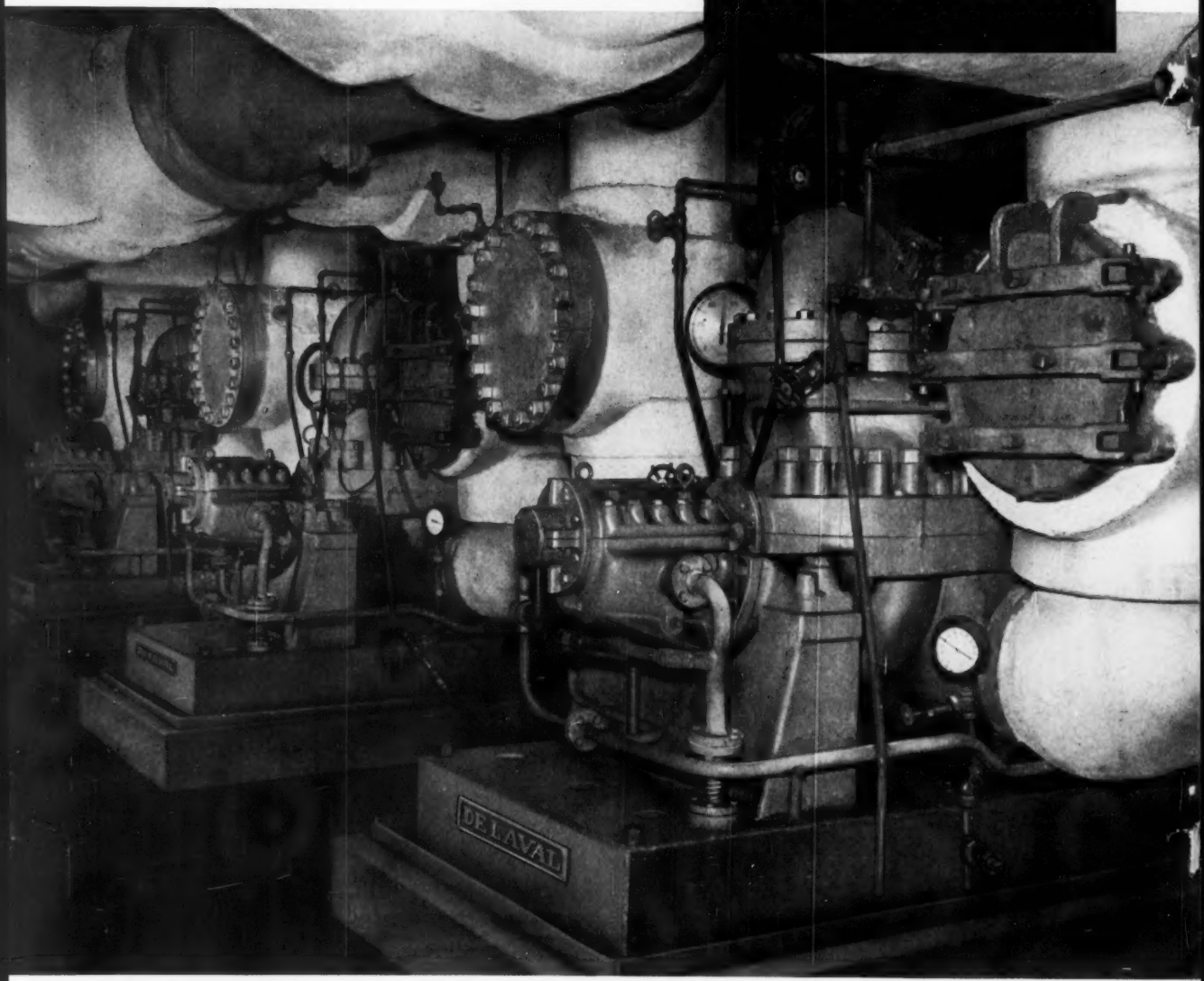
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

14,772

Con Edison *reorders*

DE LAVAL

BOILER FEED PUMPS



The three De Laval Oppeller Pumps, shown in the photograph, do a dependable job of handling boiler feedwater at the East River Station of the Consolidated Edison Co. of New York. These three-stage pumps, with double-suction in the first stage, have a capacity of 2,000 gpm and operate at a discharge pressure of 620 psig. As proof of their reliable performance, Con Edison has ordered two identical units for the expansion of this station *plus* similar pumps for their Indian Point nuclear generating station.

Excellent for *medium* pressure and temperature service, De Laval Oppeller Pumps are designed with opposed impellers that balance axial thrust. Standard design features include sleeve bearings and labyrinth wearing rings which assure long economical service.

For *high* pressure, *high* temperature boiler feed service, De Laval offers the barrel-type pump . . . a single-suction, radially split diaphragm type multi-stage pumping unit inside a forged steel barrel.

For more data on these dependable pumps, write for Catalogs 1502 and 1506

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

DL 413

In Power this month

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Print order this issue: 49,971

Crane Valves Prove Their Value on Steam Service

Out-slugs steam for 34 years!

Valve records like this can point the way to lower piping maintenance costs in your own plant!

Here you see a Crane 175-pound Ferrosteel gate valve with 34 cost-free years on 80 psi. steam service—one of a 40-valve installation made in 1923 at Long-Bell Division of International Paper Company, at Longview, Wash.

In all that time, only one of the original 40 valves has been replaced. More important, 39 of the original valves . . . and the replacement . . . are still giving dependable control of steam to kilns—with no more than routine stuffing box maintenance since installation in 1923.

Be sure *your* operation gets low-cost valve service: insist on Crane valves and fittings, from the big, complete Crane line—first choice of industry for over a century.

ASK FOR your copy of "Valve Performance Facts"—32 case histories on valve installations throughout industry. See your Crane Representative or write Crane Co. today.

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speaking of **Power**

Last month's leadoff article on electric-power distribution (March, pp 79-81) stirred up POWER readers aplenty. Some took a penned swipe at us while others settled for a gentle pat on the back. You will recall that the theme of this article was built on what the electrical industry is doing to encourage better planning of electrical-distribution systems.

One letter tackled a particularly touchy area, one we have been watching develop over the years. Consulting Engineer C R Johnson of Upper Montclair, N. J. put his finger on it when he drew on his experience and wrote:

"... you indicate that the problem [of electrical inadequacy] lies with the plant's growth. However, the problem more often is a result of local utility-system growth with its attendant higher short-circuit duty imposed on all connected customers' breakers. . . . It's a continuing problem for every industrial customer.

"Some attention should be focused on this phase of adequacy since the plant's entire operation may be affected."

We know many (maybe most) utility companies rate this problem of available short-circuit current high on their customer-relations list. And this is exactly where it belongs. Keeping industrial customers informed when any change is made on the utility system that materially affects the user's operation is certainly the general practice today.

However, should all utilities take the s-c responsibility under their wing? Or, should the industrial customer assume it is *his* worry to periodically ride herd on available short-circuit current that may be building up at his front door? As practice stands today, most plants with competent engineering assistance do keep running tabs on this area.

For more readers' views on the article that kicked off reader Johnson's letter, turn to *Comment*, p 142 in this issue.

Lou Lowley

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See panel below for directions regarding subscriptions or change of address.

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Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

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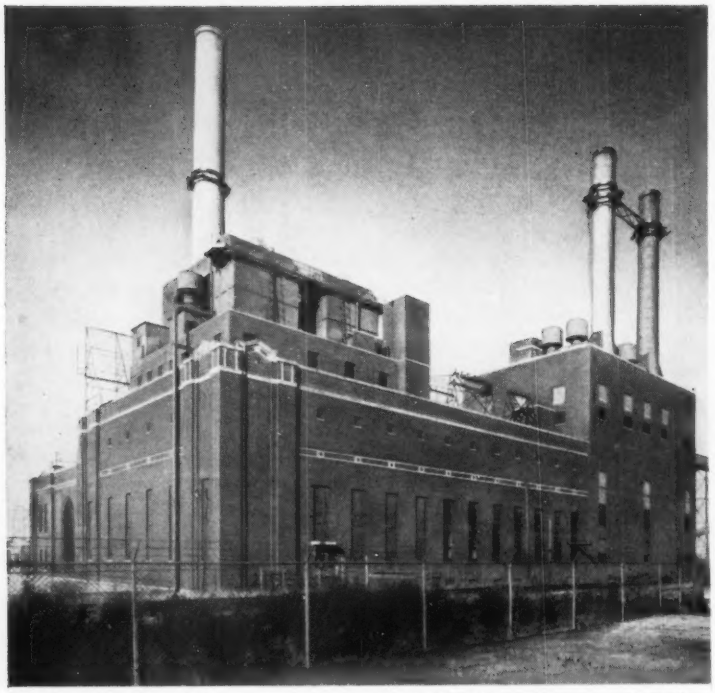
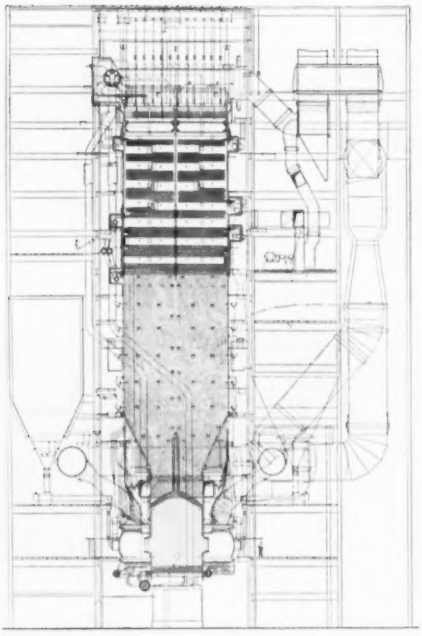


On the line for eight years at Commonwealth Edison Company's Joliet Station, 2 B&W Cyclone Furnace Boilers produce 1,200,000 pounds of steam per hour.



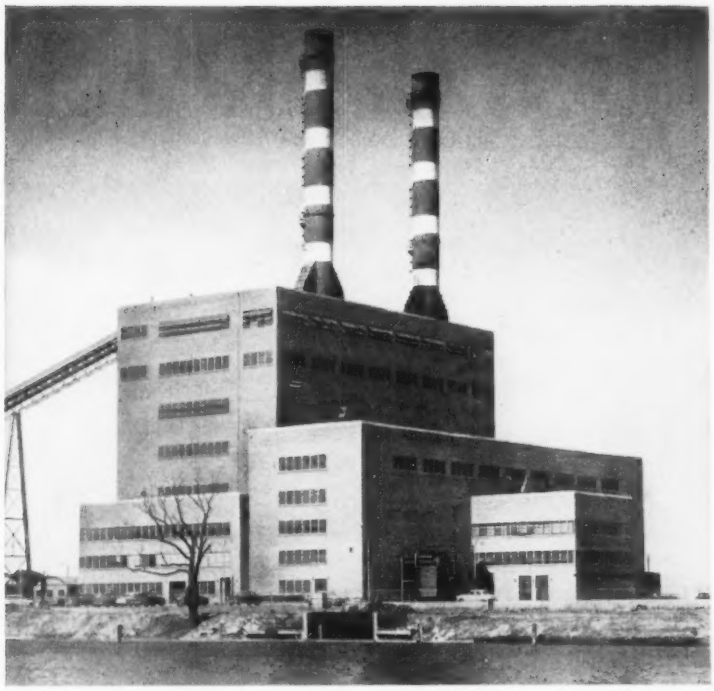
New Cyclone Furnace unit under construction for Joliet Station will generate 2,200,000 pounds of steam per hour. It will burn highly volatile Central Illinois coal with a high ash content and low ash-fusion temperature.

Proof in Action Means Continued Acceptance for B&W Cyclone Furnaces

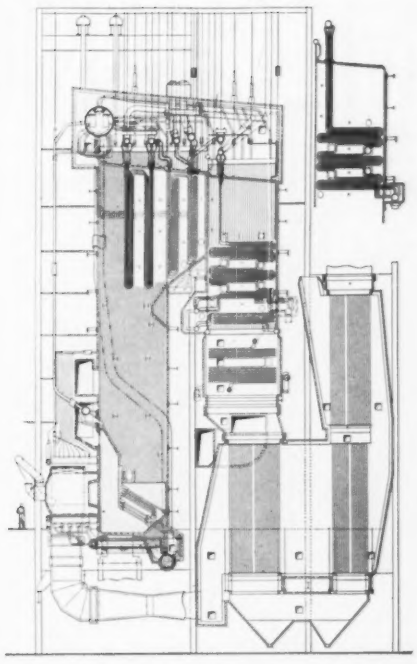
ON-LINE UNITS PROVIDE MODERN MEANS OF BURNING FUEL ECONOMICALLY

In installation after installation, the efficiency, economy and simple operation of B&W Cyclone Furnaces have led to continued acceptance. At the Commonwealth Edison Company, where the first Cyclone Furnace was installed in 1944, 14 additional units are in operation with still another on order. And at Wisconsin Power and Light Company's Edgewater Station, a Cyclone-Fired Boiler achieved such an outstanding record that B&W Cyclone Furnaces were also specified for that Company's Rock River and Nelson Dewey Stations.

The B&W Cyclone Furnace simplifies the entire process of coal preparation, combustion, ash handling and ash segregaton. Its cost-saving quality contributes to lower fuel costs and re-



Rock River Station of Wisconsin Power and Light Company. Six B&W Cyclone Furnaces fire 2 B&W Boilers to produce 1,050,000 pounds of steam per hour.



New unit for Wisconsin Power and Light's Nelson Dewey Station will use a B&W Cyclone Furnace to fire boiler producing 700,000 pounds of steam per hour.

duced maintenance as well as increased operational simplicity, flexibility and safety. Recognition of these facts is attested by the 77 Cyclone Furnace Boilers now either in service or under construction throughout the country.

Many other modern advances in combustion and high-pressure, high-temperature steam generation are also available through B&W. They merit examination in connection with your next installation. Write for further information to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

PURCHASERS OF THE B&W CYCLONE FURNACE

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Atlantic City Electric Co.	1
Baltimore Gas & Electric Co.	1
Chilena de Electricidad	2
Columbus & Southern Ohio Electric Co.	2
Commonwealth Edison Co.	16
Consumers Public Power District (Nebraska)	1
Detroit Edison Co.	1
Indiana & Michigan Electric Co.	1
Jersey Central Power & Light Co.	3
Memphis Light, Gas & Water Division	3
Middle South Utilities, Inc.	1
Missouri Public Service Company	2
Monongahela Power Co.	1
Northern Indiana Public Service Co.	3
Ohio Edison Co.	2
Ohio Power Co.	6
Public Service Co., of New Hampshire	1
Tampa Electric Co.	3
United Illuminating Co.	2
Wisconsin Power & Light Co.	4
FOR INDUSTRIAL INSTALLATIONS	
American Cyanamid Co.	1
American Enka Corp.	1
Clinton Corn Processing Co., Division of Standard Brands	1
Columbia Southern Chemical Co.	1
Consolidated Water Power & Paper Co.	1
Dow Chemical Co.	5
Eastman Kodak Co.	1
Greenwood Mills	1
International Paper Co.	4
National Container Corp., of Wisconsin	1
Rhinelander Paper Co.	1
St. Croix Paper Co.	1
Thilmany Pulp & Paper Co.	1
West Virginia Pulp & Paper Co.	1
Total	**77**

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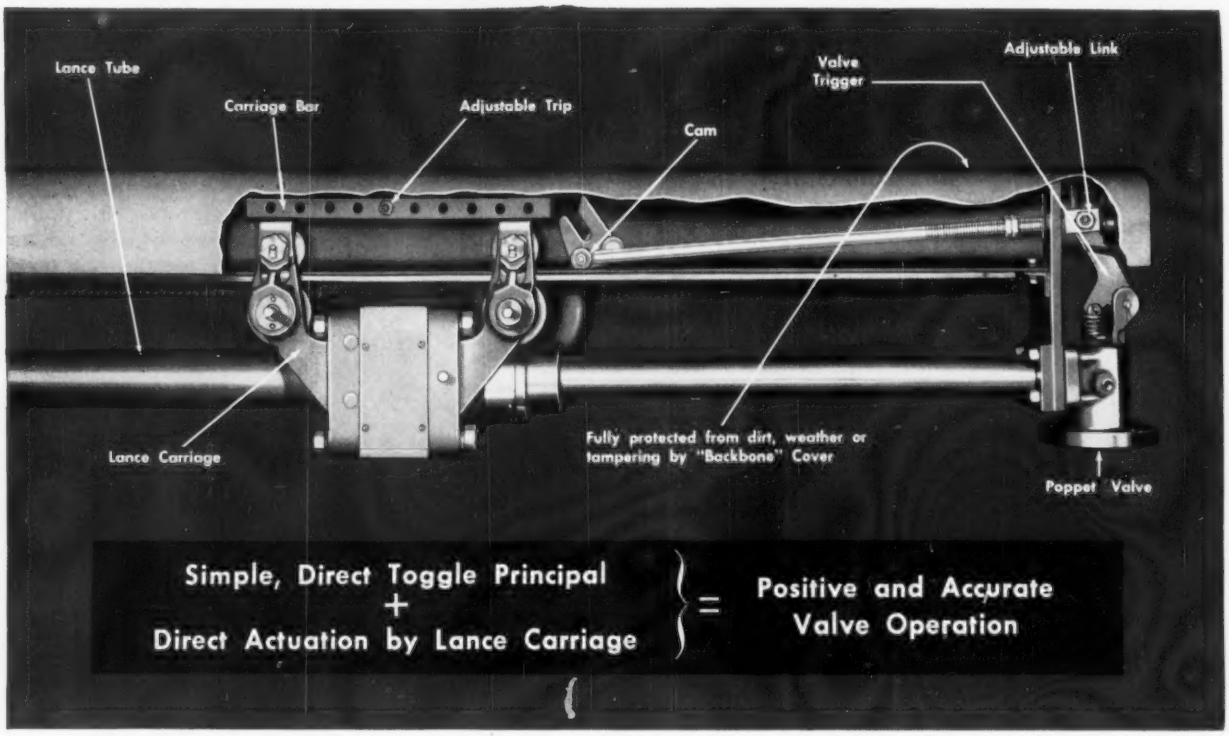
BOILER DIVISION

G-887

MECHANICALLY OPERATED



SERIES 300 IK—LONG RETRACTING BLOWER

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Backbone and Protective Cover
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- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
- Positive Gear Carriage Drive
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

Diamond

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited, Windsor, Ontario

POPPET TYPE VALVE

(WITH ADJUSTABLE PRESSURE CONTROL)

additional important features of the

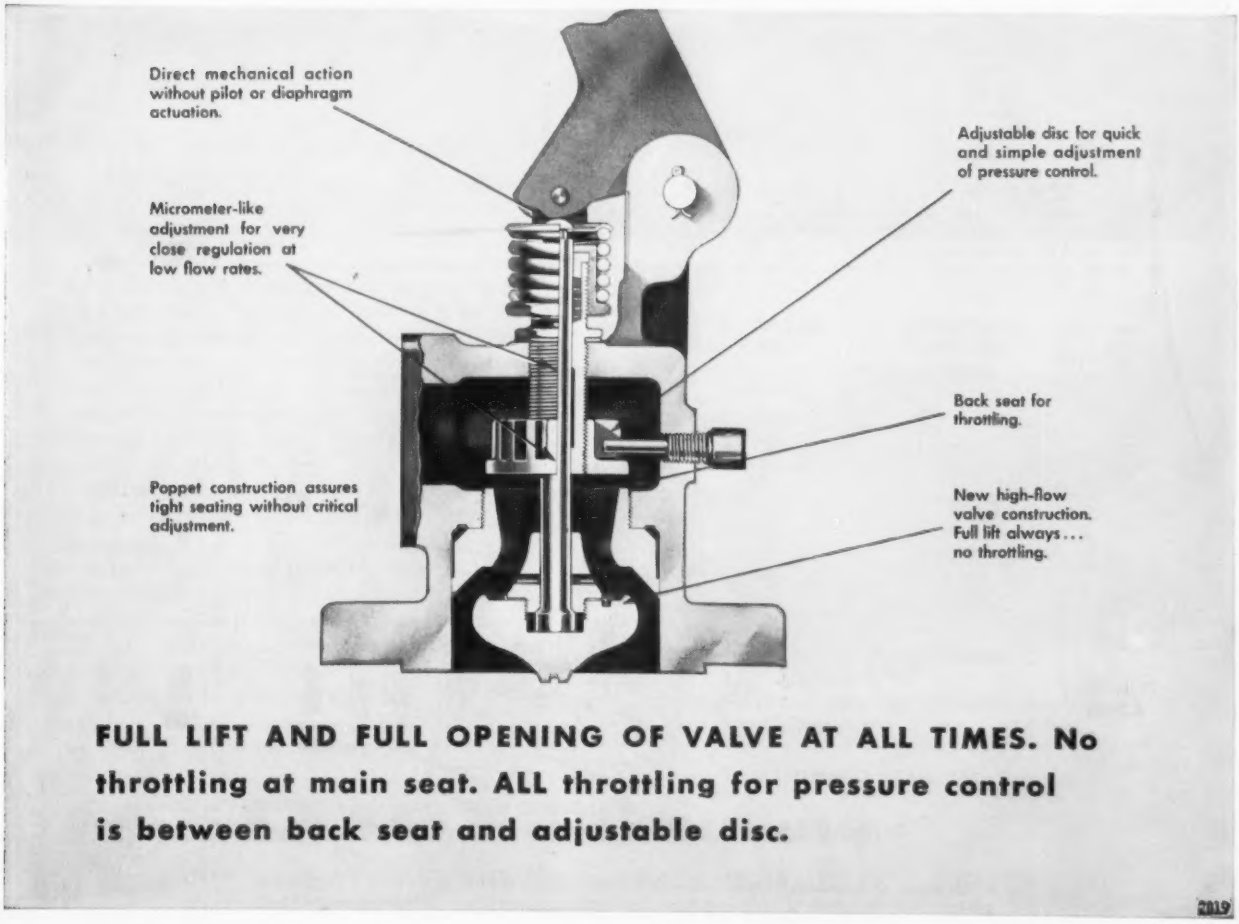
New Diamond Series 300 IK

LONG RETRACTING BLOWER

This valve was adopted for the new Series 300 IK because long experience has proved it the most satisfactory of all designs for severe blower service. More than 300,000 of this basic design are in use on various Diamond Blowers and have established notable service records. A recent improvement is more streamlined flow contours that permit higher flow rates with less pressure drop.

The direct mechanical linkage for actuating the valve offers the advantages of greater reliability and safety . . . in addition to more accurate control. Numerous other important features of the Series 300 IK are listed at the bottom of the left hand page. These are the reasons why this blower is establishing a new standard of efficiency, economy and dependability in cleaning heating surfaces that require a long retracting blower.

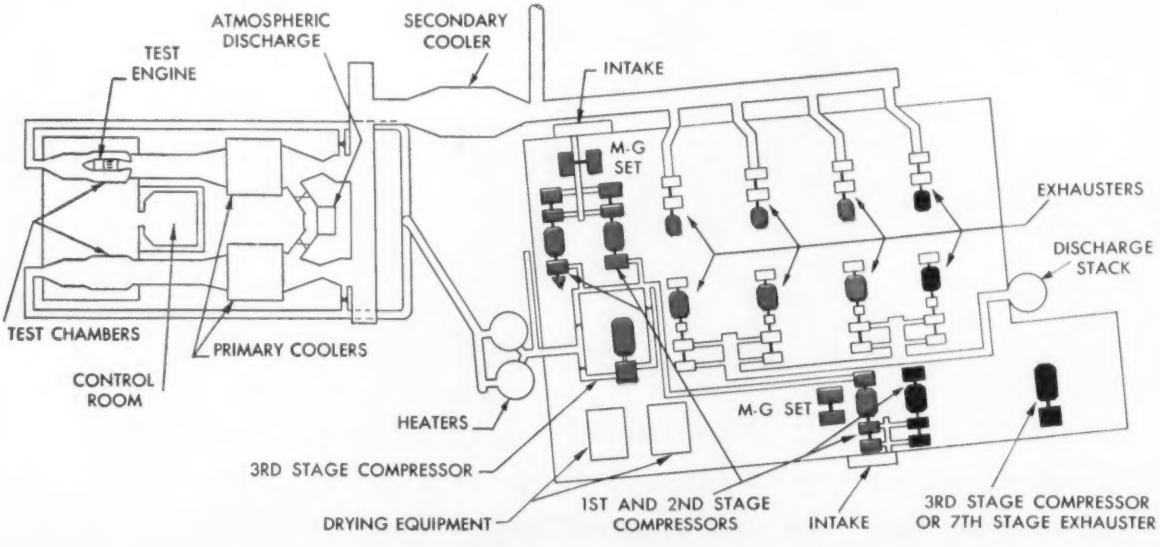
Bulletin 2111U tells much more about the Series 300 IK; ask your local Diamond office or write directly to Lancaster for a copy.


Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Poppet construction assures tight seating without critical adjustment.
Adjustable disc for quick and simple adjustment of pressure control.
Back seat for throttling.
New high-flow valve construction. Full lift always... no throttling.

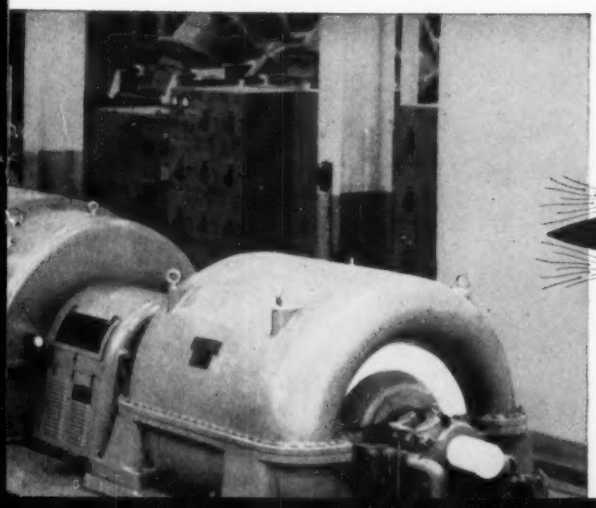
FULL LIFT AND FULL OPENING OF VALVE AT ALL TIMES. No throttling at main seat. ALL throttling for pressure control is between back seat and adjustable disc.

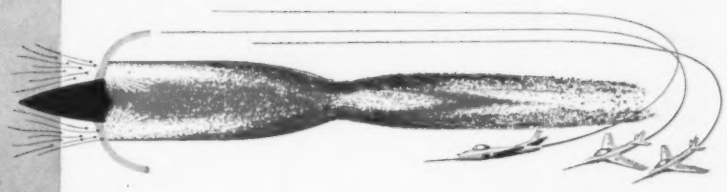
2019

Each line of Elliott combustion air compressors (two are shown above) involves three casings. There are two first-stage casings with a total atmospheric inlet capacity of 106,000 cfm, discharging at 29.6 psia to the inlet of the second stage, which discharges at 60 psia. Unit at left shows, in the foreground, an Elliott radial in-flow expander. Behind the expander is the second-stage compressor, then the 16,500-hp, 3600-rpm synchronous motor, and beyond that are the two first-stage casings. In the background is the Elliott motor-generator set, a 5000-hp, 900-rpm wound-rotor induction motor driving a 4650-kva, 720-rpm alternator used for starting the synchronous motors.



In this layout of Propulsion Systems Laboratory, Elliott equipment already installed is indicated in orange. Elliott equipment on order and to be installed in the near future is indicated in solid black.





ELLIOTT COMPRESSORS AND MOTORS speed the nation's research at NACA's Lewis Flight Propulsion Laboratory

TO ACCELERATE important aircraft propulsion research, the National Advisory Committee for Aeronautics constructed the Lewis Flight Propulsion Laboratory in Cleveland. Testing facilities in the Propulsion Systems Laboratory at Lewis simulate jet engine speeds up to Mach 3 (three times the speed of sound at any given altitude) and altitudes above 60,000 ft.

To help create a wide range of in-flight conditions, important Elliott compressor and electric equipment has been installed. This includes Elliott combustion air compressors, and large 3600-rpm synchronous motors. In fact, to date the horsepower of Elliott motors installed and on order totals over 218,000, and the capacity of Elliott centrifugal compressors, over 359,000 cfm.

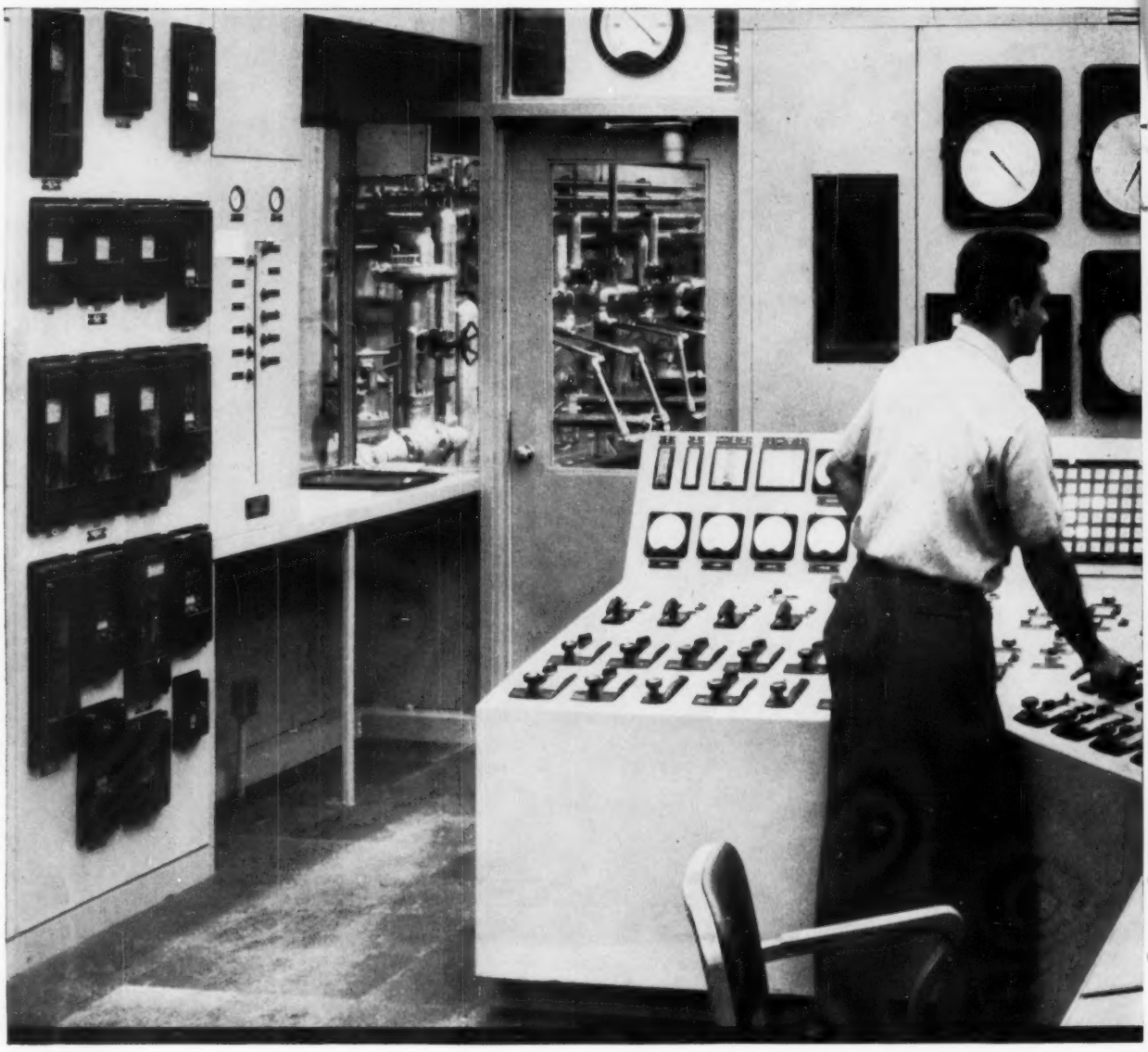
For information on how Elliott quality products can help you, call the nearby Elliott District Office, or write Elliott Company, Jeannette, Pa.

One of a line of three Elliott 10,000-hp, 3600-rpm synchronous motors which drive the second- and third-stage exhausters.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS
CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Q7-2



How Bailey stretches

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

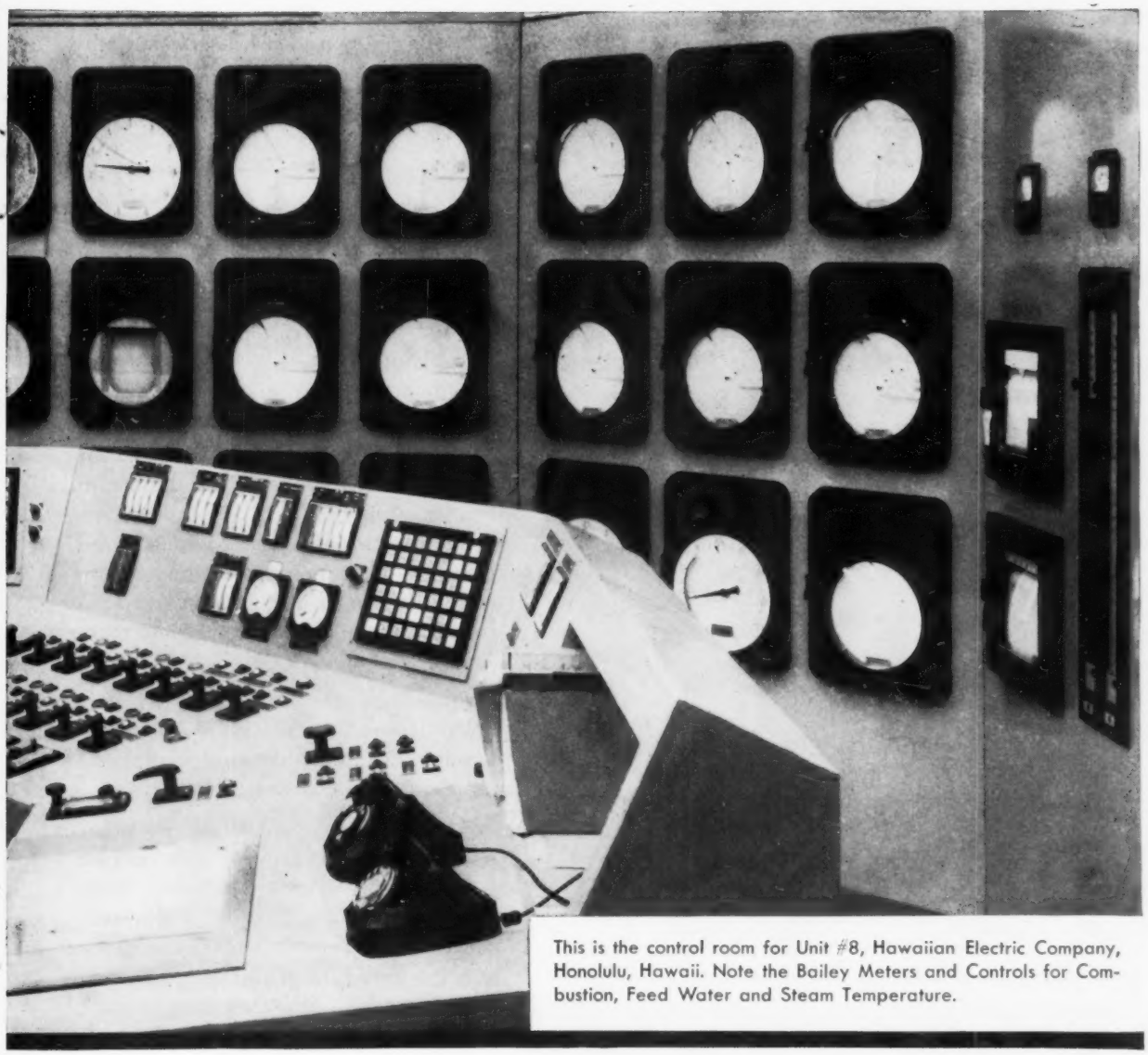
Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men



This is the control room for Unit #8, Hawaiian Electric Company, Honolulu, Hawaii. Note the Bailey Meters and Controls for Combustion, Feed Water and Steam Temperature.

your fuel dollar

who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A132-2

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

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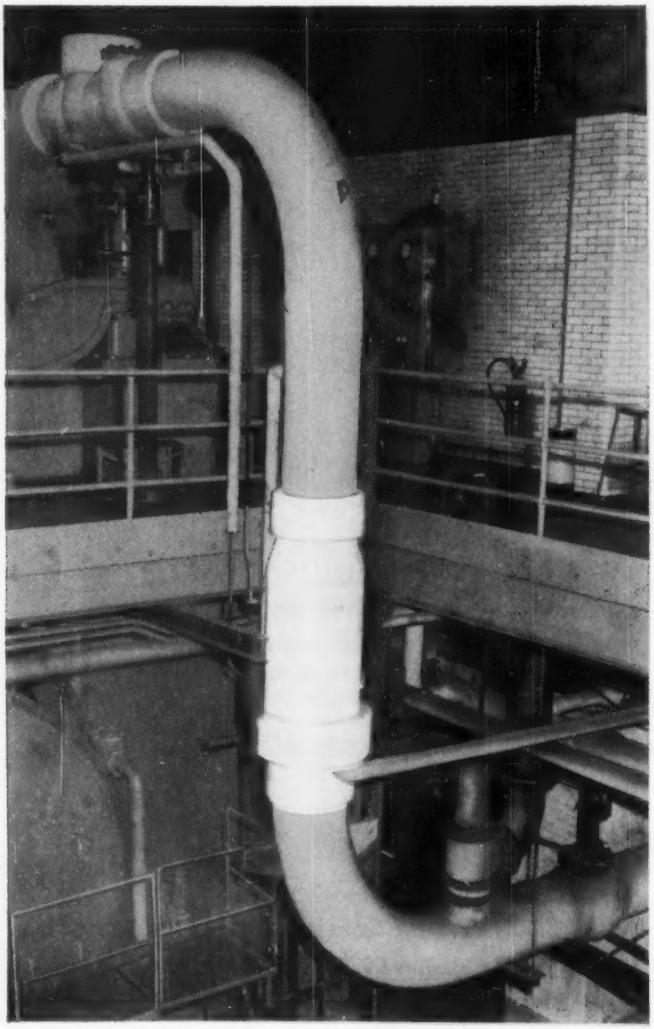
In Canada—Bailey Meter Company Limited, Montreal

New Copes-Vulcan Desuperheater handles critical job at Pennsylvania Electric Company



Copes-Vulcan's newly developed Variable-Orifice Desuperheater provides precise temperature control at Pennsylvania Electric Company's Front Street Station. Installed in the steam header supplying a 12,500-kw turbine generator, this desuperheater has maintained a discharge steam temperature of 490 FFT even though inlet temperature has varied between 600° and 650°.

Located just 20 feet upstream of the turbine throttle this desuperheater holds temperatures within a plus or minus 3F limits, consistently meets all required pressure conditions.

Advance design pays off in other ways, too. Only one outside connection —for cooling water—is needed. With only one moving part, this desuperheater presents no maintenance problem. No long runs of piping are needed to mix fluids. No atomizing steam, spray nozzle or glands are required.

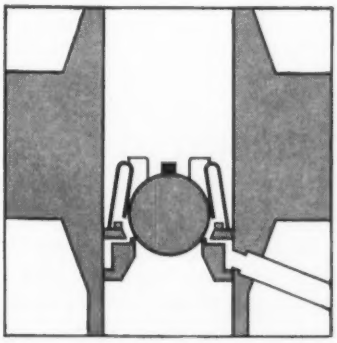
Copes-Vulcan designs a complete line of desuperheaters, each type engineered to meet particular operating conditions. For complete details on the Variable-Orifice Desuperheater, write for Bulletin 1037.

COPES VULCAN

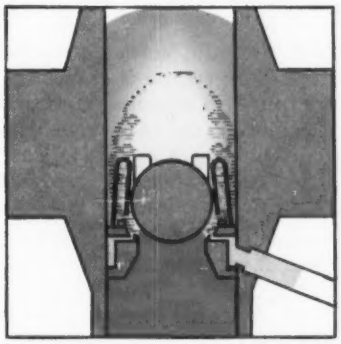
Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

BLAW-KNOX

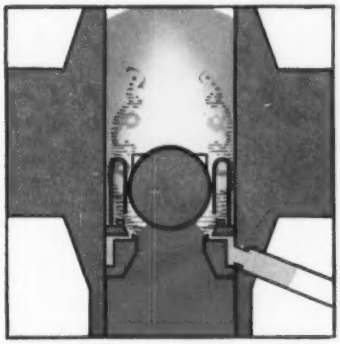
SIMPLE PRINCIPLE OF OPERATION



No load: Ball has seated itself on the ring. There is no flow of steam—no flow of cooling water.

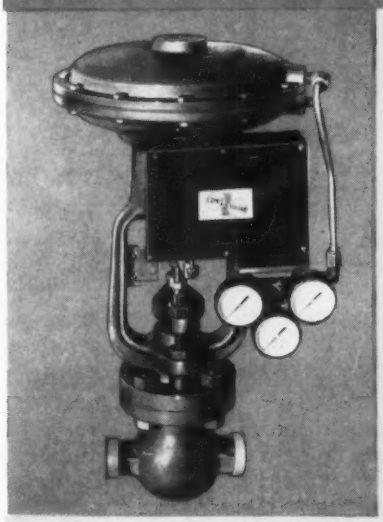


Light load: Ball opens orifice slightly. Cooling water is instantly and intimately mixed with steam.



Full load: Orifice fully opened. There is the same pressure drop and high turbulence at all loads over the full range.

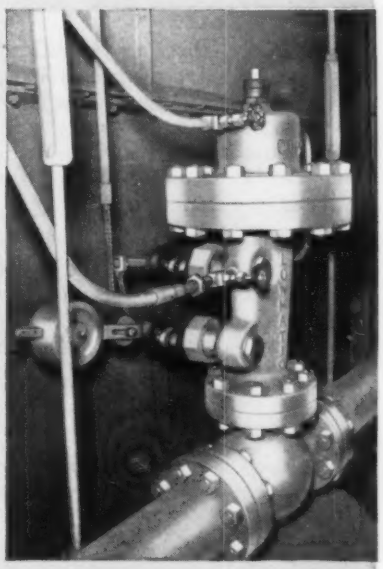
C-V NEWS NOTES



A Type CV-D Pressure reducing valve is used at Front Street Station to automatically regulate the cooling water supplied from the feed-water-heater.

This Copes-Vulcan diaphragm valve is designed to dependably meet rigid standards of accuracy for pressure, temperature and liquid level control. The Type CV-D may be direct or reverse acting. Rangeability is excellent.

Style and area of valve ports are scientifically selected to meet specified operating conditions. These versatile valves can be applied in sizes up to 12 inches in pressure—standards up to 1500 pounds. For details on Copes-Vulcan valves, write for Bulletin 1027.



For modern feed water control: The Copes Flowmatic, a two-element feed water regulator, is sensitive to the slightest change in steaming rate, and to the most minute fluctuation of boiler water level.

Closer stabilization of boiler water level under all load conditions makes the Copes Flowmatic ideal for the modern utility and industrial boilers subject to rapid, wide fluctuations in steam demands.

With the direct-operated Flowmatic Regulator (shown above) the steam flow element is built integral with the valve bonnet. In regular service outdoors, the Flowmatic Type D-O is unaffected by atmospheric conditions, provides accurate, dependable performance. For further information, write for Bulletin 1003-A.

BK-4411

JENKINS PRACTICAL PIPING LAYOUT

80

How to plan piping connections

FOR A SWIMMING POOL WATER CIRCUIT

Swimming pool water must be kept clean, sanitary, and invitingly clear. If used in cool weather, provisions for heating the water are necessary also. These requirements can be met with a circulating system in which the water is constantly drawn off, treated with suitable chemicals, passed through filters, warmed when required, and returned to the pool.

In the diagram showing the piping connections for a swimming pool water circuit, water is drawn off by a pump protected with a strainer to remove hair, lint and other foreign matter. The water is treated with soda or other chemicals to render it slightly alkaline, which makes it more comfortable for swimming, and simplifies further water treatment. Chlorine is added to kill bacteria; alum or other chemicals to inhibit the growth of algae and coagulated suspended solids. The water is then filtered, warmed in a heater, and returned to the pool through inlets. No make-up water connection is shown because most sanitary codes require an independent supply.

In normal operation of the water circulation system, valves L and O are open while M and N are closed, which permits water passage through filters and prevents flow to the drain. Closing valve R and opening valve S will bypass the heater when it is not needed, or requires maintenance. Steam admission to the heater is controlled by a thermostatic valve.

Filter cleaning by "back washing" is done by closing valves L and O, and opening M and N. In this operation water is forced through the filters in reverse direction, and discharged to drain. The pool may be emptied to drain by closing valves M and P, and opening L and N.

O. S. & Y. valves are recommended throughout the system to prevent fluid action on the spindle threads. All-Iron and Ni-Resist valves are specified for the water circuit, and stainless steel valves where direct exposure to chemicals is encountered. Steam system valves are all-bronze or bronze with stainless steel trim.

Jenkins Fig. 3244 Ni-Resist, O.S. & Y. U-Bolt Gate, is used for shut-off control of flow to filters and heater. The solid iron wedge automatically adjusts to seats, assuring drop-tight closure, and the spindle collar backseats against bonnet, permitting repacking under full pressure. Accurate alignment of steel U-Bolt to body bonnet lugs permits easy dismantling and reassembly.

Jenkins Fig. 1312 or Fig. 1313, Stainless Steel Globe Valves, are recommended for control of chemical and drain flow because of their high resistance to corrosive media. The twin bolted bonnet and body design facilitates dismantling for cleaning and regrinding, and is especially suitable where chemicals might destroy conventional body-bonnet threading.

To assure efficiency in the job when planning any major piping installation, consult accredited piping engineers and contractors.

To make certain of trouble-free, economical valve performance, select your valves from the Jenkins Catalog. It shows types and patterns, made of different metals, for an endless variety of needs.

For prompt, capable help when you want Jenkins Valves and other supplies for your job, call the top-flight distributor who represents Jenkins in your city.

***SEND FOR NEW BULLETIN** describing in detail Jenkins Fig. 3244 and the complete line of Jenkins Ni-Resist Gate Valves for use wherever corrosion or erosion is a problem. It's informative, useful, and yours for the asking.*

JENKINS BROS.
100 Park Avenue, New York 17

Please send Bulletin 205 on Ni-Resist Gate Valves.

Name.....

Title.....

Company.....

Address.....

Fig. 3244
NI-RESIST
GATE VALVE
fitted with type 316 stainless steel trim
O. S. & Y. U-Bolt screwed, sizes ½"—2" 225 lbs. O.W.G.

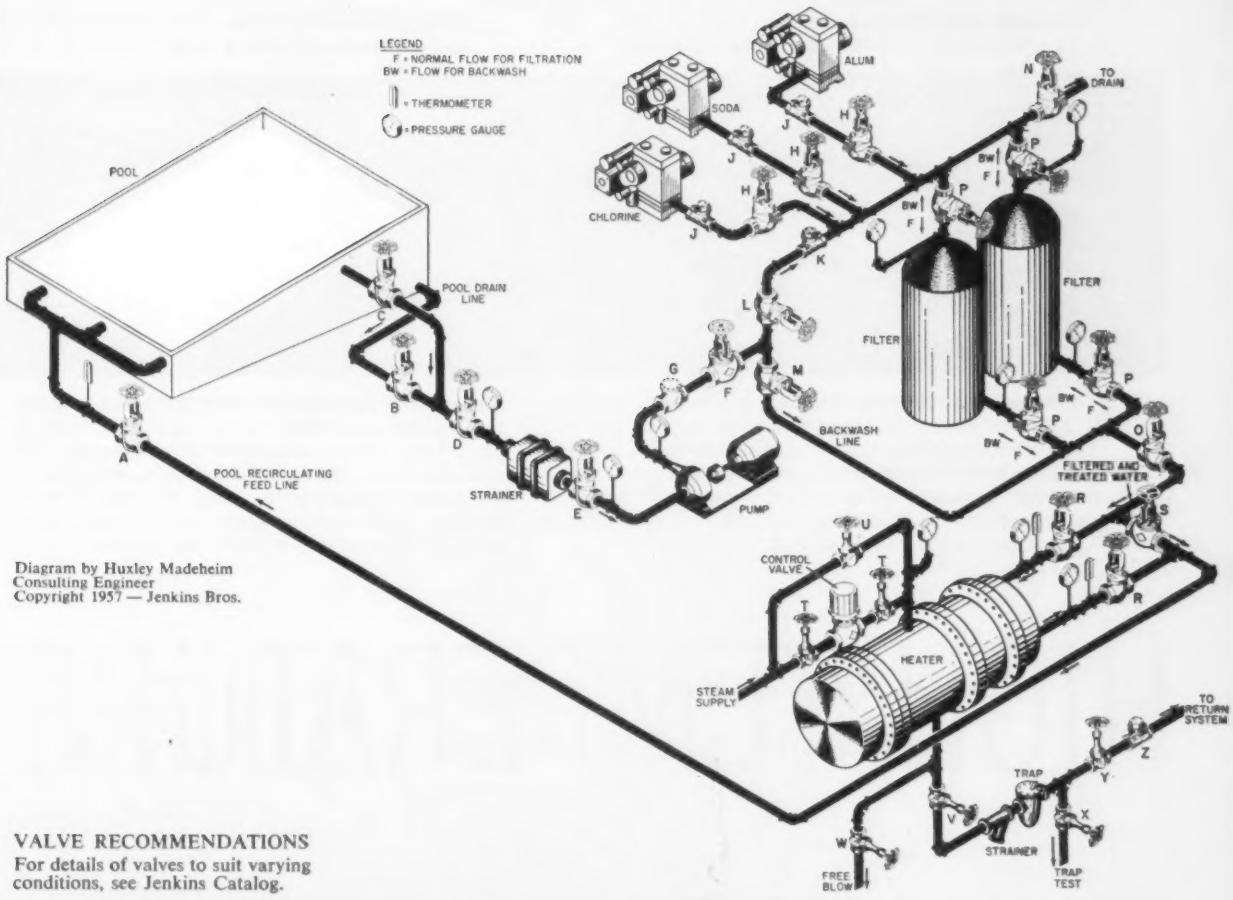


Diagram by Huxley Madeheim
Consulting Engineer
Copyright 1957 — Jenkins Bros.

VALVE RECOMMENDATIONS

For details of valves to suit varying conditions, see Jenkins Catalog.

Code	Quan.	Jenkins Valve	Service
A	1	Fig. 3244 Ni-Resist Gate	Shutoff recirculation line to pool
B	1	Fig. 3244 Ni-Resist Gate	Pool drain shutoff
C	1	Fig. 3244 Ni-Resist Gate	Vacuum cleaning conn. shutoff
D	1	Fig. 3244 Ni-Resist Gate	Strainer inlet shutoff
E	1	Fig. 3244 Ni-Resist Gate	Shutoff strainer outlet & pool circ. pump inlet
F	1	Fig. 80 All Iron Globe	Control pool circ. pump discharge
G	1	Fig. 84 All Iron Swing Check	Prevent backflow through pool circ. pump
H	3	Fig. 1312 or 1313 S. S. Globe	Control chemical treatment feeders
J	3	Fig. 1328 S. S. Swing Check	Prevent backflow to chem. treatment feeders
K	1	Fig. 1328 S. S. Swing Check	Prevent backflow of chem. treatment to pump & BW line
L*	1	Fig. 3244 Ni-Resist Gate	Shutoff pool flow to filters — Normal filtration
M*	1	Fig. 3244 Ni-Resist Gate	Shutoff pool flow to filters — Backwash cycle
N*	1	Fig. 1312 or 1313 S. S. Globe	Control flow to drain
O*	1	Fig. 3244 Ni-Resist Gate	Shutoff recirc. flow to heater & pool
P	4	Fig. 1302 S. S. Gate	Shutoff filters

Code	Quan.	Jenkins Valve	Service
R	2	Fig. 3244 Ni-Resist Gate	Shutoff pool water heater
S	1	Fig. 80 All Iron Globe	Control bypass flow about pool water heater
T	2	Fig. 47-U Bronze Gate	Shutoff steam supply control valve to pool water heater
U	1	Fig. 106-A Bronze Globe	Control bypass flow st. supply pool water heater
V	1	Fig. 47-U Bronze Gate	Shutoff steam trap
W	1	Fig. 546-P S. S. and Bronze Globe	Control free flow
X	1	Fig. 546-P S. S. and Bronze Globe	Control steam trap test
Y	1	Fig. 47-U Bronze Gate	Shutoff return system from trap
Z	1	Fig. 92-A Bronze Swing Check	Prevent backflow from return system

	*Normal Cycle Filtration	*Backwash Cycle Filtration
L	OPEN	CLOSED
M	CLOSED	OPEN
N	CLOSED	OPEN
O	OPEN	CLOSED

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LOOK FOR THE JENKINS DIAMOND
VALVES
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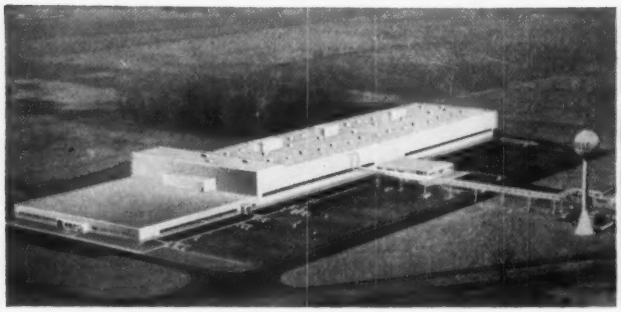
THE CROSS COMPANY—Fraser, Michigan
Consulting Engineers, Giffels & Vallet, Detroit, Michigan



Installed at this new ultra-modern plant are two 12-million BTU capacity C-E Hot Water Boilers. When this pioneer producer of automation equipment studied their heating requirements, they calculated that this system would provide the lowest fuel and maintenance costs. Their actual winter operating experience proved the soundness of this decision.

CONVAIR-ASTRONAUTICS—San Diego, California
Consulting Engineers, Pereira & Luckman

When this division of the General Dynamics Corporation determined that more space was needed for their Atlas Intercontinental Ballistic Missile project, this new center for research, development, manufacturing, and primary testing of the Atlas was decided upon. Installed in this center of space flight research will be two 30-million BTU C-E Hot Water Boilers.

HIGH TEMPERATURE

ADVANTAGES

—of high temperature water:

1. Higher available heat—many times that of steam at the same pressure.
2. Closer control of temperature.
3. Lower heat loss . . . unused heat returns to the boiler . . . no condensate return lines.
4. No elaborate feedwater treatment . . . make-up requirements are exceptionally low.
5. Steam traps not required . . . trap problems and expense are eliminated.
6. No blowdown losses . . . no safety valve vent losses . . . no condensate losses.

—of the C-E Hot Water Boiler:

1. Complete control of circulation in system and boiler.
2. No separate boiler pump needed . . . pressure loss is low.
3. Pressurized operation with oil or gas means no induced draft fan.
4. Single-pass design—no baffles—means cleaner boiler and lower draft loss.
5. Controlled, positive circulation permits more efficient arrangement of heating surfaces.
6. Any fuel—oil, gas, coal, or any combination of fuels.
7. Gas-tight, welded steel casing.
8. Fewer headers, all of which are easily accessible.

COMBUSTION

Combustion Engineering Building

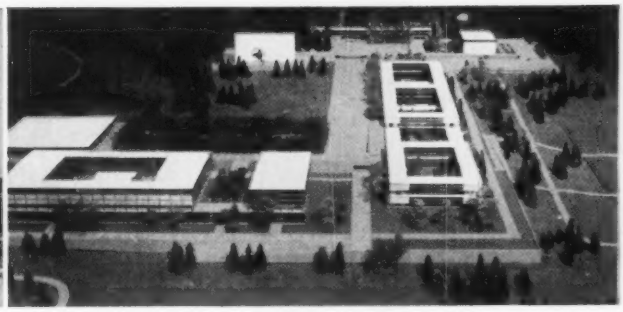
CANADA: COMBUSTION ENGINEERING-

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

RIVERVIEW COMMUNITY HIGH SCHOOL—Riverview, Michigan
Consulting Engineers, Bennett & Straight, Detroit, Michigan

To keep pace with the expanding need for more educational facilities, Riverview, Michigan has recently finished this fine, modern high school. Its heating requirements are met by two 10-million BTU C-E La Mont Controlled Circulation Hot Water Boilers.

U.S. AIR FORCE ACADEMY—Colorado Springs, Colorado
Consulting Engineers, Skidmore, Owing & Merrill



Typical of our Air Force's widespread acceptance of high temperature water for various of their installations is the selection of five C-E Hot Water Boilers for their new academy. These units will furnish heat for living, academic, and service areas here.

WATER today's new idea in large-space heating

In such diverse applications as industrials, large educational institutions, and military bases, high temperature water is finding rapidly increasing acceptance as an ideal means of heating large areas.

A big factor in bringing this trend about is The C-E La Mont Controlled Circulation Hot Water Boiler. Using the same principle as that applied by C-E in many of the country's largest utility boilers, this new boiler provides a degree of temperature control that makes it the most attractive method of heating in many cases. With a wide range of capacities — from 10 to 300 million Btu's — these boilers operate at water pressures up to 500 psi and temperatures to 470F, or higher. Depending upon local conditions, a C-E Hot Water Boiler can save from 10 to 20 per cent in maintenance and operating costs.

The smaller capacity Hot Water Boilers are completely shop assembled, while the intermediate and large units are shipped in varying stages of assembly. This C-E practice greatly reduces erection costs.

So, if you are in the market for boilers, either for space heating or process requirements, it may prove greatly to your advantage to investigate the use of high temperature water as your heat source. Because individual needs vary, both steam and hot water have their place. Our engineers will be pleased to discuss either method with you or your consultants —impartially and with no obligation.

For further details on high temperature water boilers by C-E write for our catalog HCC-2.

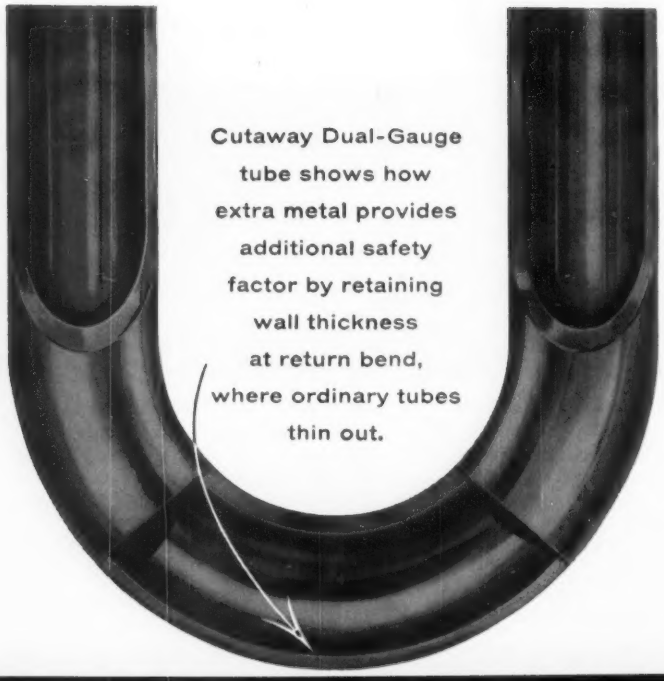
ENGINEERING

C-120

200 Madison Avenue, New York 16, N. Y.

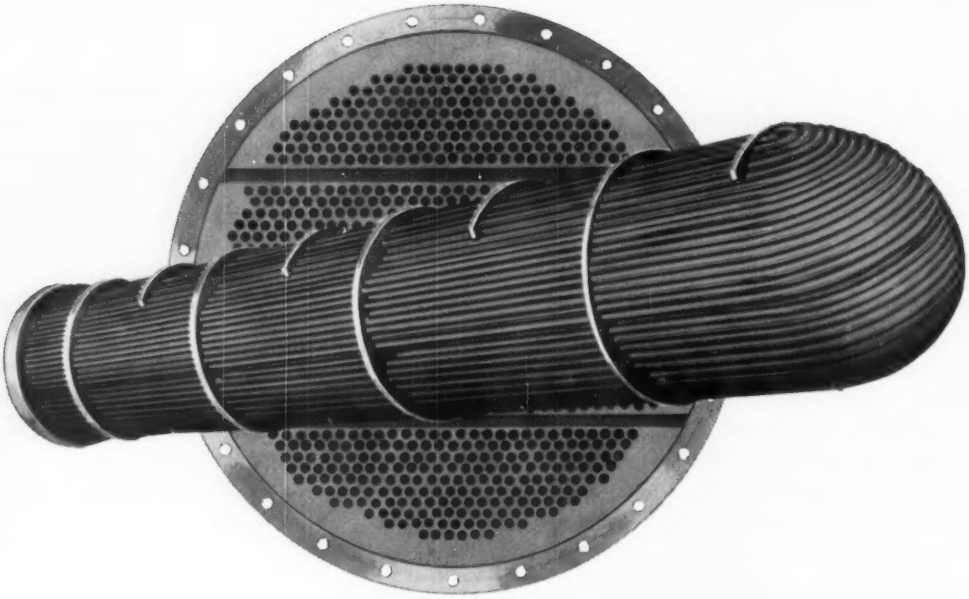
SUPERHEATER LTD.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



Specify

DUAL-GAUGE



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To keep tubes uniformly strong
in condensers, feed water heaters,
heat exchangers and similar equipment . . .

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TUBING!

Provides heavier wall thickness:

a. At one or more points in tube length to compensate for thinning on outer portions of return bends.

b. At points of support.

c. At tube ends to meet special requirements.

Produced in all standard sizes or manufactured to the particular design requirements of individual customers.

Available in Cupro-Nickel, Red Brass, Aluminum Brass, Admiralty metal and Muntz metal.

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MINE TO MARKET
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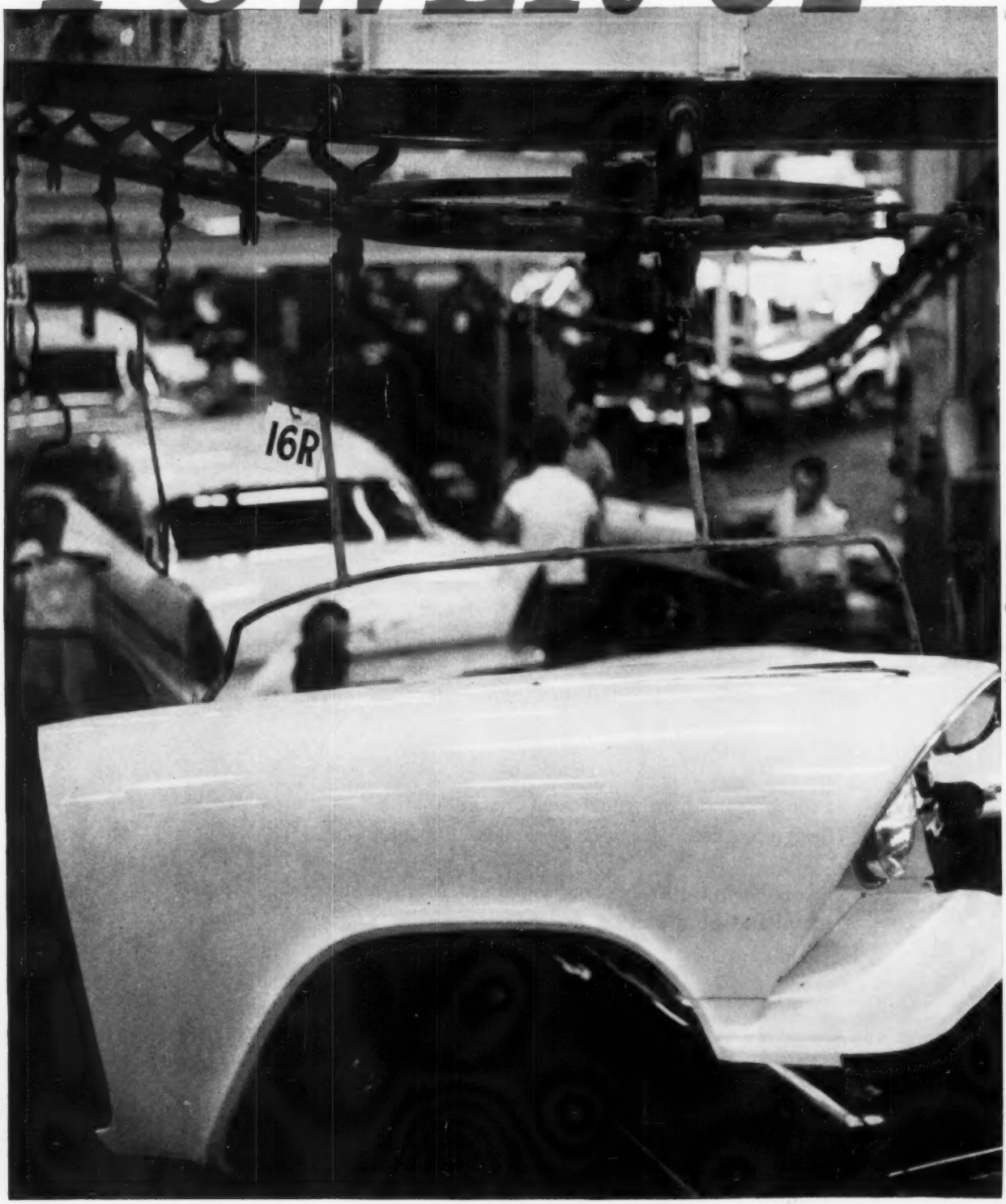
POWER-UP



Chrysler Corporation did . . . and synchronized production flow for modern, car-a-minute assembly

Today, forward-looking uses of electric power and static electrical control are helping reach a long-sought goal of synchronized, modern assembly at the Plymouth plant in Newark, Delaware. Chrysler Corporation benefits include: improved handling procedure, more accurate scheduling and simplified maintenance.

Two and one-half miles of floor conveyor and over five miles of overhead monorail conveyor are automatically synchronized for exact match-up of body parts. Transfer from one conveyor to another is completely automatic at hundreds of transfer points.

Pushbutton sorting, storing and transfer of auto body shells is provided by Cypak* control systems at several large storage conveyor banks.

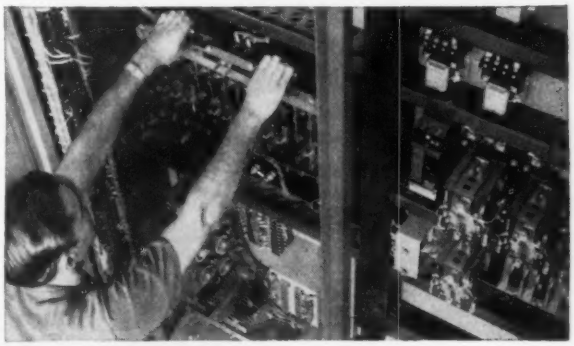
Electrical planning has provided for fast, efficient trouble-shooting. Cascade-type control interlocking of conveyor drives automatically starts and stops conveyor in sequence.

Your Westinghouse and electric utility representatives are helping many plants POWER-UP . . . Why not ask for experienced help to get better production and more profit from your electrical dollar?

*Trade-Mark

J-97227

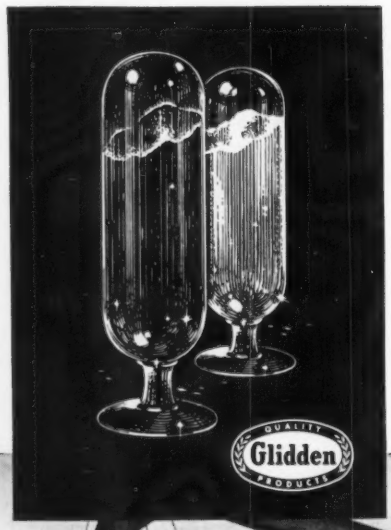
YOU CAN BE SURE...IF IT'S Westinghouse



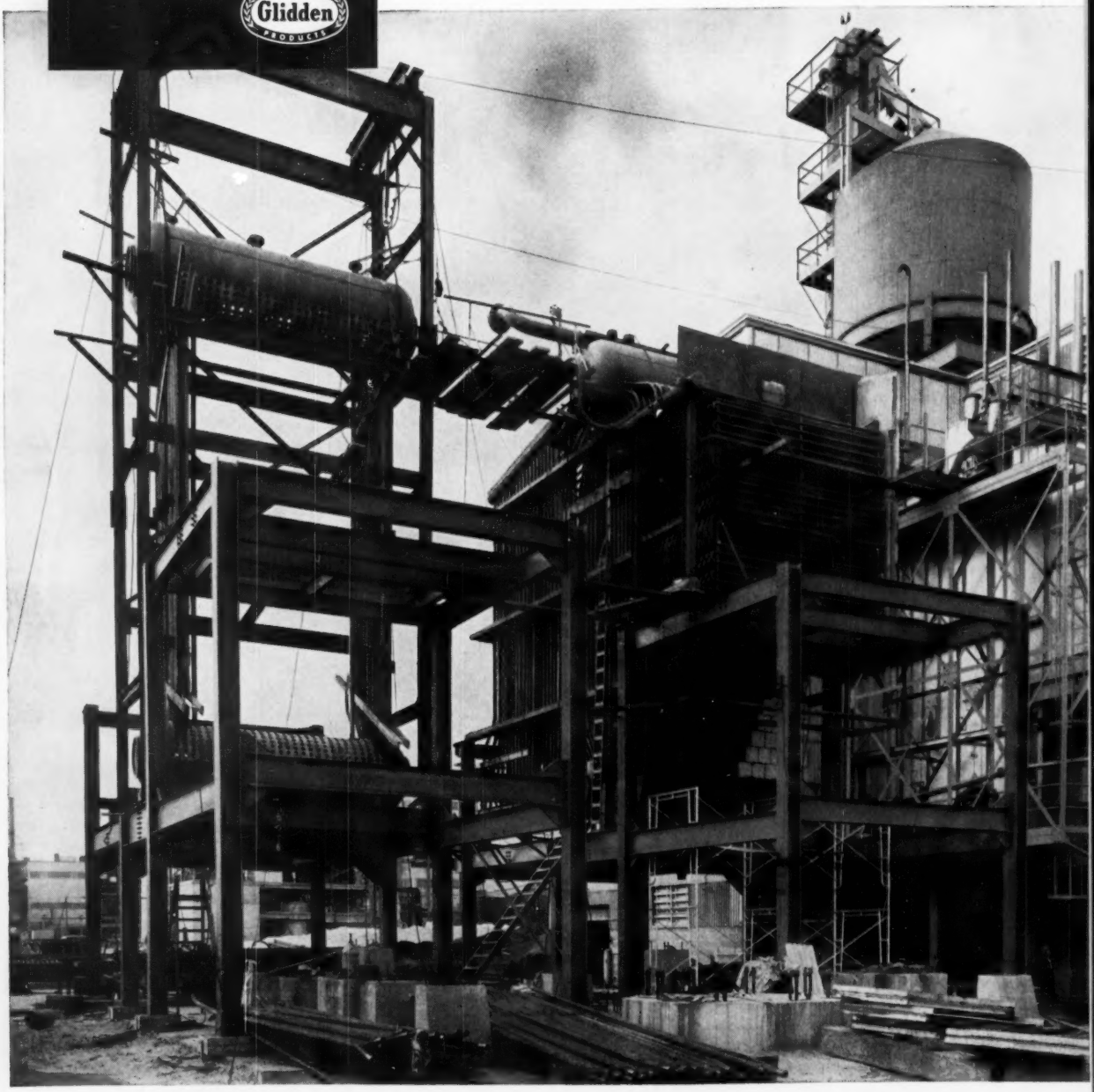
Westinghouse AV Drive cabinets group the adjustable voltage d-c power and regulator systems for each conveyor. Magamp* automatic speed and position control regulates conveyor travel to bring ivory fenders to the ivory body shell on time.

*Trade-Mark

Pushbutton selection of stored auto bodies depends upon Cypak static control for automatic follow-through at each transfer point. Cypak was selected for this complex job to greatly reduce maintenance and size of control circuitry.



Power for producing Republic



Glidden pigments starts with ELECTRUNITE Boiler Tubing

Keeping pigment production up is a big job that demands power plant dependability. And dependable power starts with Republic ELECTRUNITE® Boiler Tubing at the new Adrian Joyce Works of the Chemicals-Pigments-Metals Division, The Glidden Company, Baltimore, Maryland.

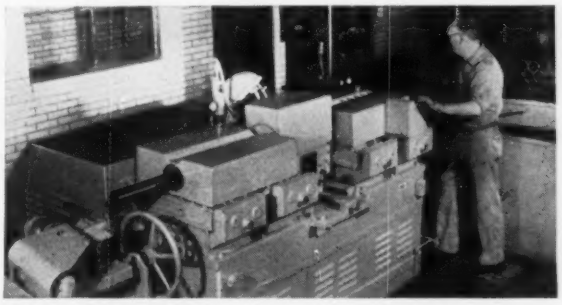
There, jet black ore is transformed into ZOPAQUE Titanium Dioxide—whitest white that meets practically all formulations for the brilliant pigments used in producing plastic, paint, rubber, paper, ceramic, and other products.

Power for this pigment production comes from units of 70,000 pounds per hour with 725 p.s.i. saturation temperature. These units were designed, constructed, and installed by Riley Stoker Corporation. Republic ELECTRUNITE was used throughout for the boiler waterwalls and the economizer.

Republic Tubing was installed with the assurance of built-in quality. ELECTRUNITE is made of highest quality flat-rolled open-hearth steel produced in Republic's own mills to Republic's rigid specifications.

Each length of Republic ELECTRUNITE Boiler Tubing is hydrostatically or electronically tested to conform with the applicable ASTM specifications and the ASME Boiler and Pressure Vessel Code, as well as local, state, and boiler insurance requirements. Stress values for Republic ELECTRUNITE tubes are the same as those for tubes made by other processes for temperatures up to 850°F mean tube temperature. Various sizes and wall thicknesses of ELECTRUNITE are available for pressures over 2000 p.s.i.

For dependable boiler, condenser, heat exchanger operation, specify Republic ELECTRUNITE. For additional facts call your Republic representative or send the coupon below.



SPECIFY FARROWTEST®—the most conclusive nondestructive electronic tubing test in use today. Developed by Republic, FARROWTEST detector coils electronically spot irregularities in tube walls which would be hidden from routine test procedures. Send for free brochure.

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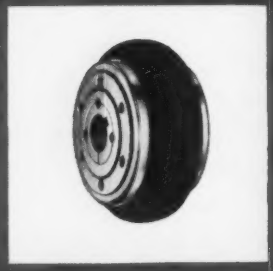
Up to 825 hp



NOW! THE COUPLING WITH THE 4-WAY FLEX!

DODGE Para-flex

FLEXIBLE CUSHION COUPLING

THE NEW IDEA IN FLEXIBLE COUPLINGS... WITH A FLEXING BODY THAT AUTOMATICALLY COMPENSATES FOR ALL COMBINATIONS OF MISALIGNMENT AND END FLOAT... AND CUSHIONS SHOCK LOADS!

THIS Coupling "swallows up" misalignment! Its ability to handle multiple displacement is exceeded only in a universal joint. It outperforms the most complex coupling mechanisms—yet it operates with the simplicity—*and the dependability*—of a modern tire!

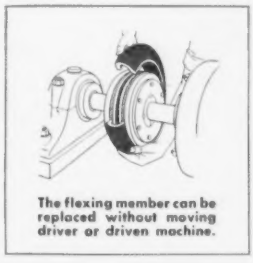
The technological advances that contribute to the miracle of today's truck tires, which are engineered to carry tremendous loads at high speeds and stand terrific shock, have made this new type of coupling possible.

The heart of Para-flex is a tire with synthetic tension members bonded together in rubber. It is pliant. It "fits itself" to changing shaft conditions—angular, parallel, end-float, *or any combination of all three!* Depending upon the size of coupling and duration of shaft misplacement, it handles angular misalignment up to 4°, parallel up to ⅛" and end-float up to 5/16".

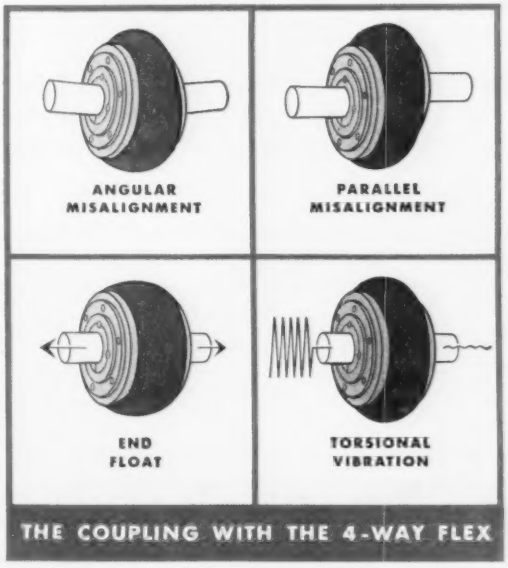
It cushions the stresses of shock loads to a remarkable degree. And it tends to absorb torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

There is no metal-to-metal contact between shafts. They are insulated. No lubrication is required.

Para-flex takes a minimum of space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine!*



The flexing member can be replaced without moving driver or driven machine.



THE COUPLING WITH THE 4-WAY FLEX

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 825 hp at 1200 rpm. Call your distributor for early delivery to *make your own test.* You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 3200 Union Street, Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods in the mechanical transmission of power. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer." Or write us.

In the last two years...

All These Improvements

Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.

1. New Cyclo-trell—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

Cottrell Automation System—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

2. Opzel Collecting Electrodes—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

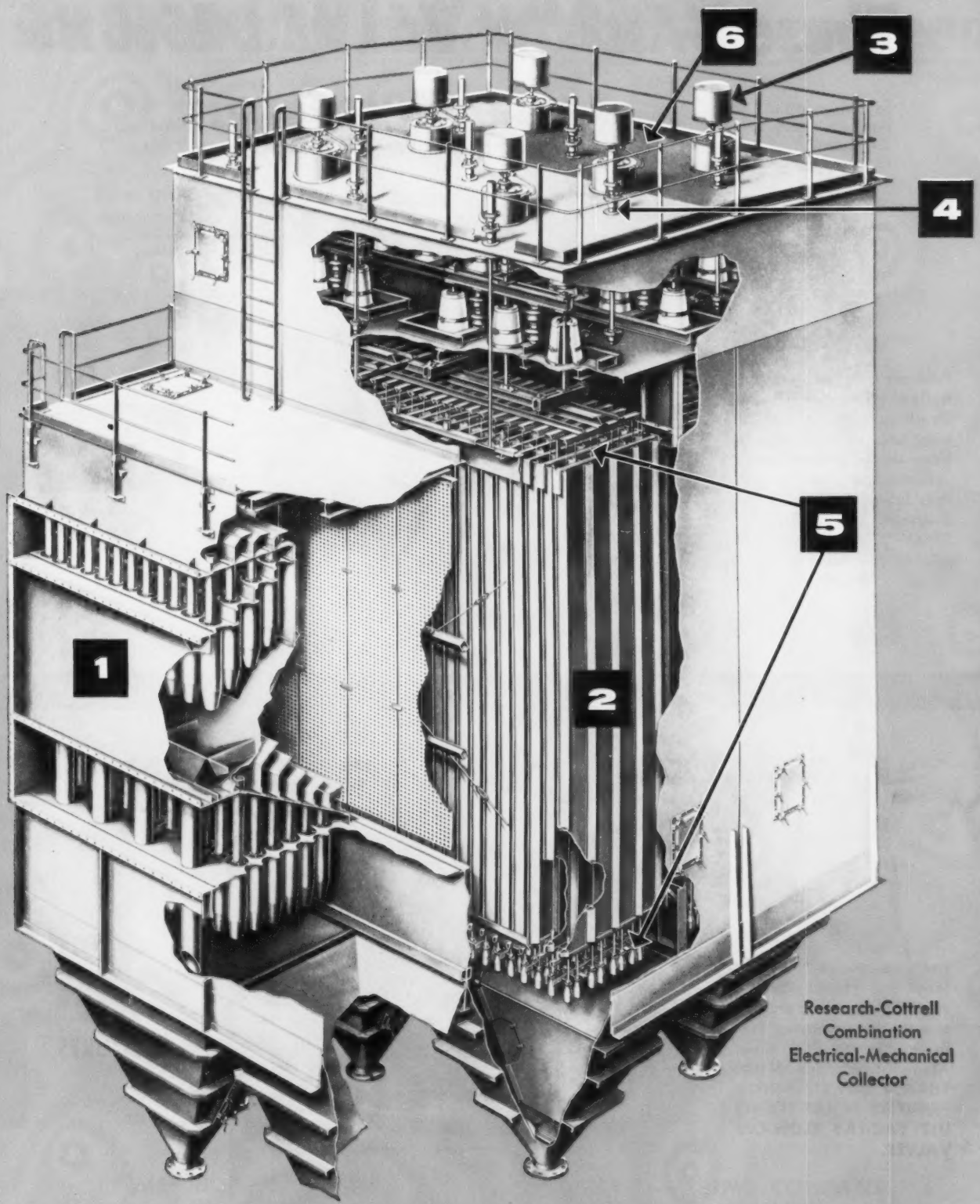
3. New Discharge Electrode Rappers—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

Silicon Rectifiers—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

4. M. I. Rappers on Roof—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

5. New Discharge Electrodes—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

6. New Top Constructions—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.



Research-Cottrell
Combination
Electrical-Mechanical
Collector

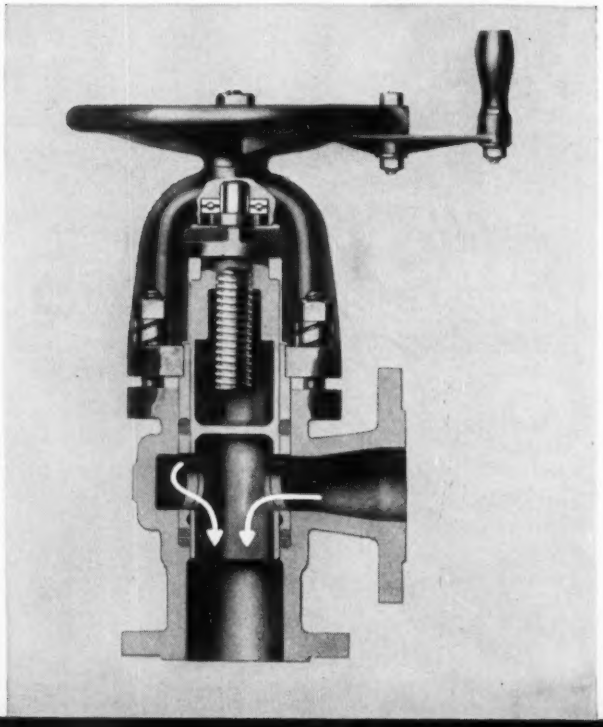
Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y.
• Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif.
• Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

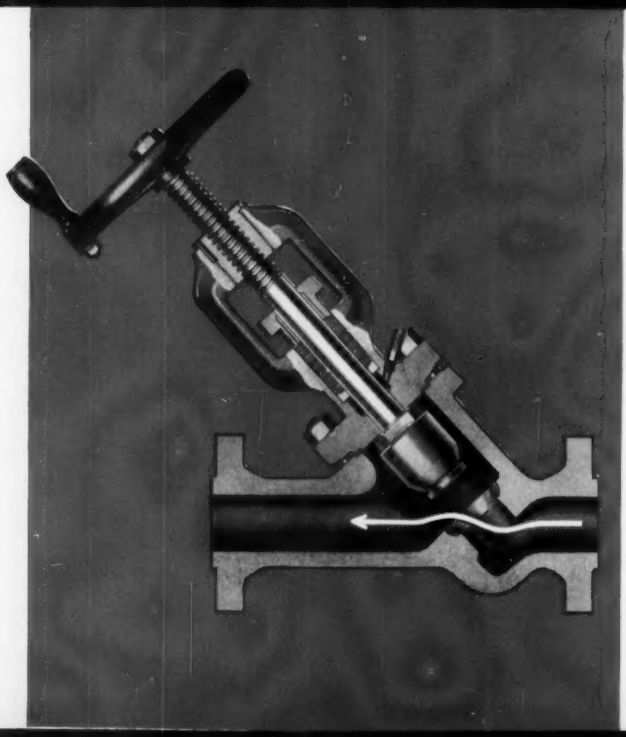
Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.



FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

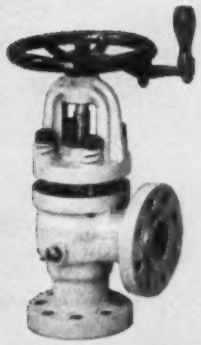
serve every boiler blow-down need

■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

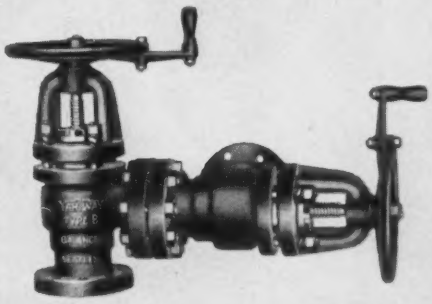
Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).



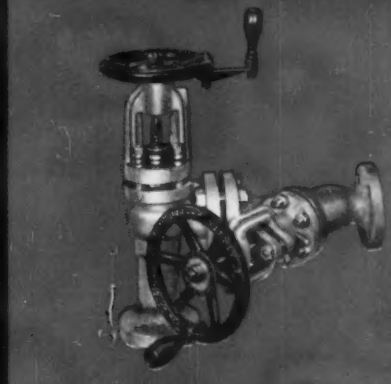
• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.



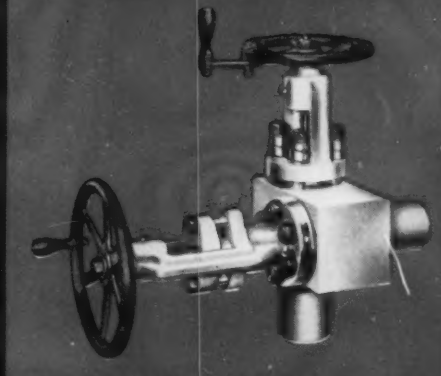
• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

• Yarway Hard-Seat Blow-Off Valve for pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.



• Yarway Hard-Seat—Seatless Bolted Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard seat-hard seat tandems for pressures to 2500 psi. See Bulletin B-434.



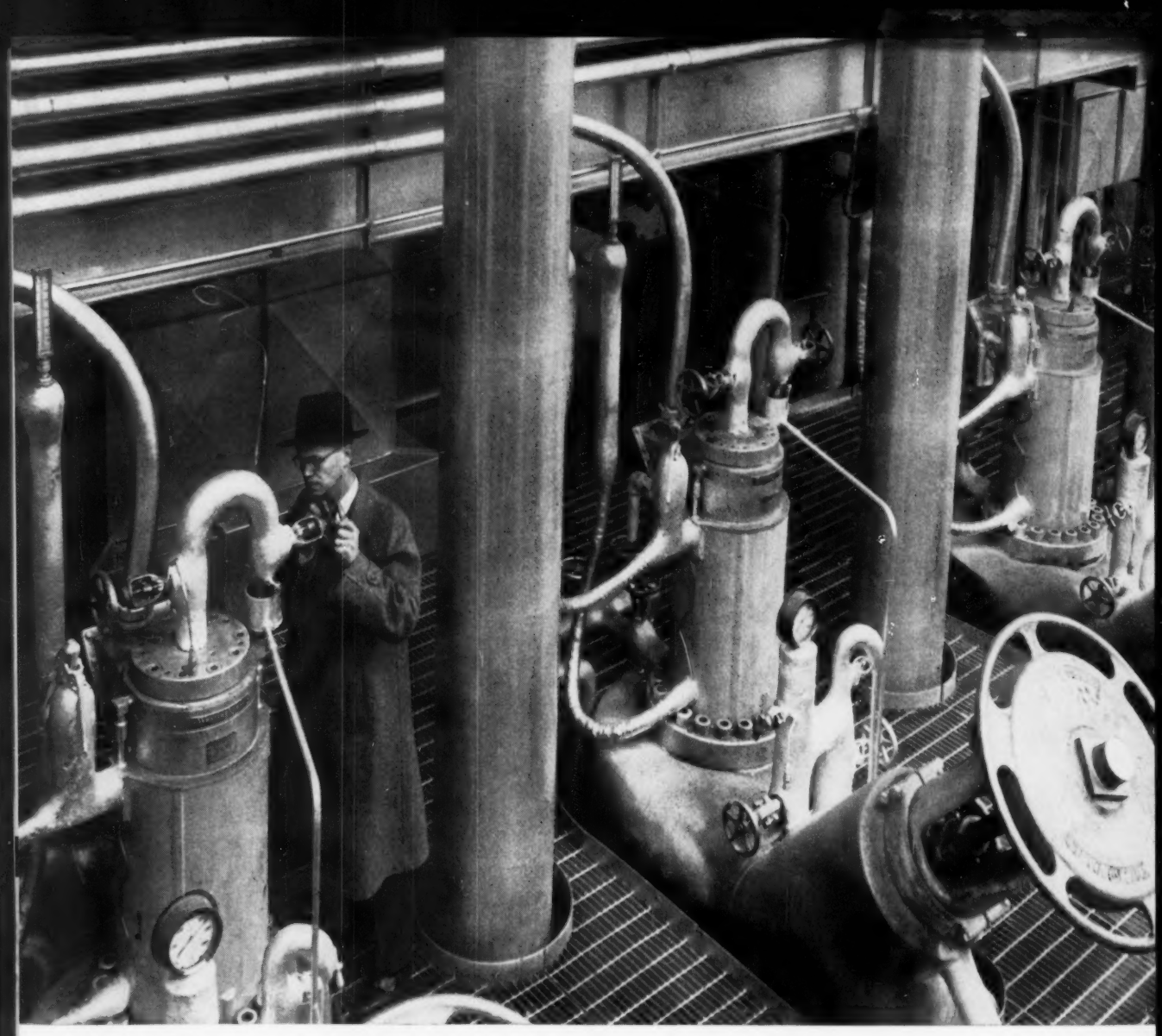
• Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY®

blow-off valves



Westinghouse canned motor-pumps

specified for KP&L outdoor installation

The Kansas Power and Light Company recently increased the capacity of its Tecumseh Station with the addition of a 75,000-kw outdoor unit. This new addition, the most efficient in the plant, will operate day and night as the base load unit. To insure reliability, Westinghouse canned motor-pumps were specified for the Combustion Engineering Inc. controlled circulation boiler.

Westinghouse pumps were selected because: they have been proven for long-term continuous operation in many other installations; the zero-leakage feature eliminates injection water sealing. Two pumps provide the required boiler water circulation to deliver 635,000 pounds of 1000°F steam at 1800 psi. A third Westinghouse pump is kept on hot standby. All three are rated at 4070 gpm, 1958 psi, 615°F.

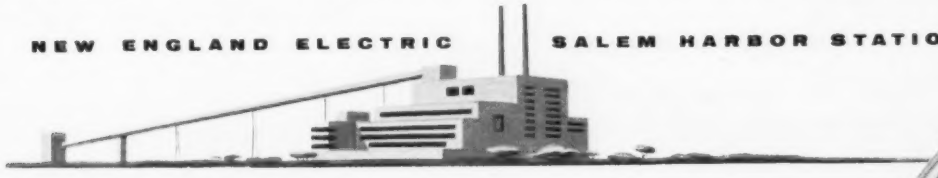
For further information on the tested and proven Westinghouse canned motor-pumps, contact your Westinghouse sales representative, or write: Westinghouse Electric Corporation, Atomic Equipment Dept., P.O. Box 217, Cheswick, Penna.

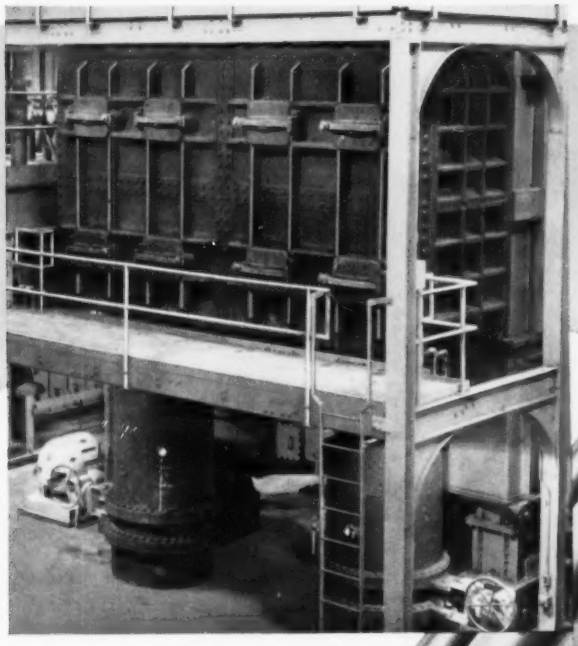
J-57019

YOU CAN BE SURE...IF IT'S Westinghouse

where trouble-free performance is a matter of pride...

NEW ENGLAND ELECTRIC | SALEM HARBOR STATION





this condenser is tubed with...

HEAT EXCHANGER TUBE

One of the Northeast's most modern and efficient steam power plants, Salem Harbor is being expanded to deliver 300,000 kw to New England's homes and industries.

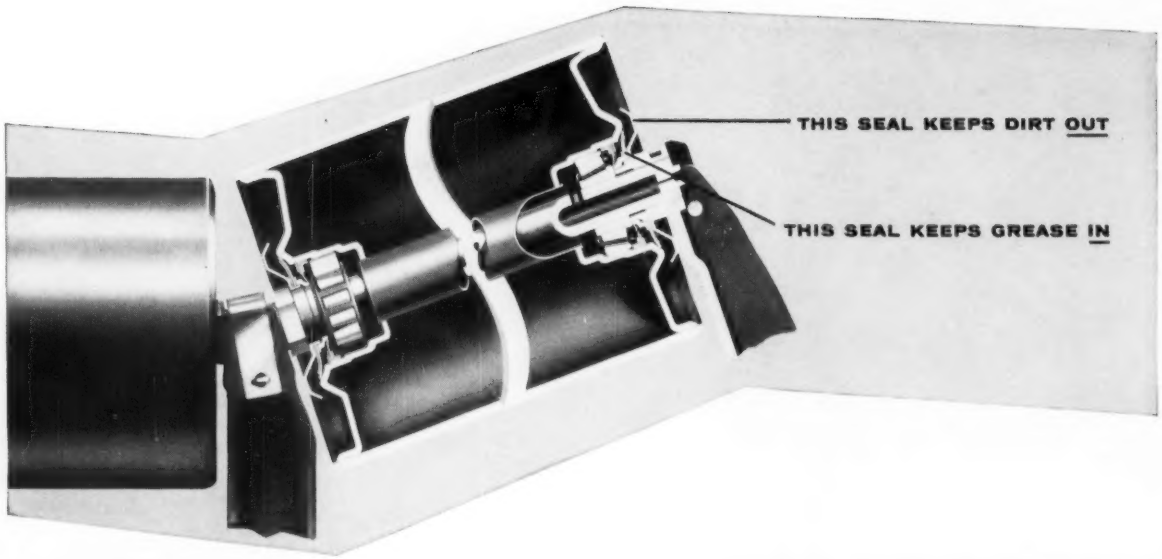
Scovill Aluminum Brass Heat Exchanger Tube has been specified for installation in condensers serving Salem Harbor's 80,000 kw reheat-type turbo-generators . . . where trouble-free operation is essential in maintaining high efficiency.

Let Scovill Technical Service and Scovill Heat Exchanger Tube help you, also, to achieve trouble-free performance.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

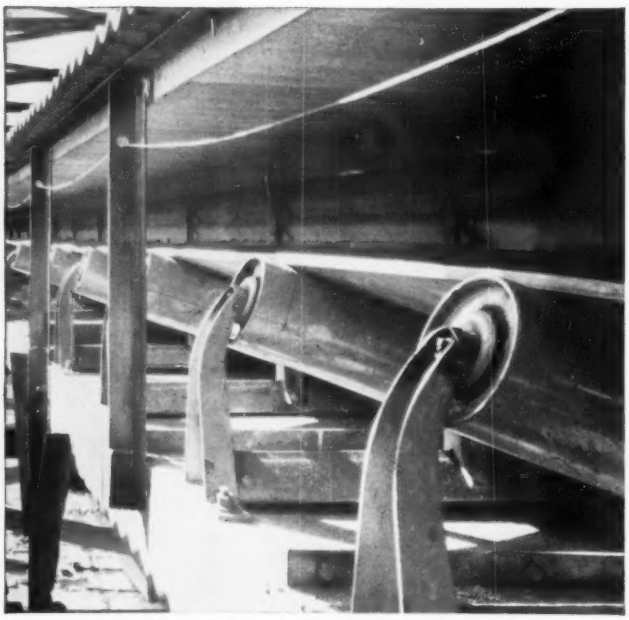
Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

HEAT EXCHANGER TUBES For Applications from Marine to Petrochemical, From Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube



JEFFREY PERMASEAL® IDLERS

The best built idlers for the toughest jobs



Belt conveyor equipped with Jeffrey PERMASEAL® Belt Idlers handling coal at a power generating station.

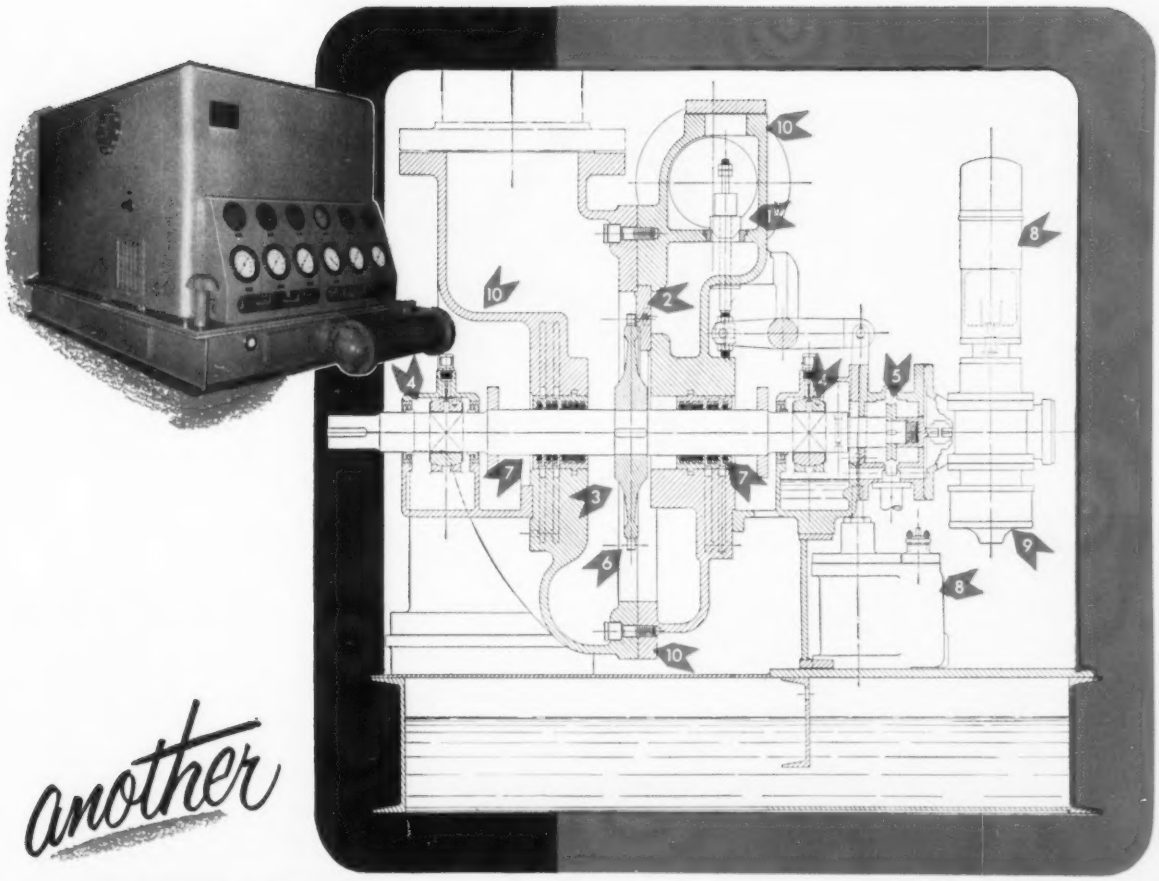
Grease can't get out to foul conveyor belts; dirt can't get in to damage bearings. Diaphragm double seals protect both ends of every roller. That's why Jeffrey Permaseal idlers give extra-long service with an absolute minimum of maintenance.

Greater dependability and longer life offset the slightly higher initial cost for Permaseal idlers. Pay off quickly on the tough jobs. Pay off, too, through less downtime, fewer replacements and lower upkeep on all belt conveyors.

Your materials-handling supervisor should have the new Catalog 909, Jeffrey Belt Conveyors. It has valuable design and descriptive data on these products. For a copy, write The Jeffrey Manufacturing Company, 932 North Fourth Street, Columbus 16, Ohio.

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY



another

MURRAY INSIDE STORY . . . OR WHY MURRAY EXCELS FOR MULTI-VALVE COMPRESSOR DRIVE

1. Multiple automatic bar-lift inlet valves.
2. Stainless steel nozzle block.
3. Specially shaped forged alloy steel disc and shaft — separate or integral.
4. Spherical seated, pressure lubricated sleeve bearings.
5. Kingsbury thrust bearing.
6. Special integral spacer type accurately formed stainless steel blades.
7. Carbon or labyrinth type gland seals.
8. NEMA Class D precision oil relay governor with hydraulic servomotor.
9. Positive displacement, shaft driven lubrication oil pump.
10. Heavy duty, rugged construction throughout.

Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.

Murray TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

In All

Hammond Plant near Rome, Georgia. Three 100,000 KW steam-electric units are in operation.

14" Alloy Steel Gate Valve
Pressure Seal Type
Geared Head Operation.

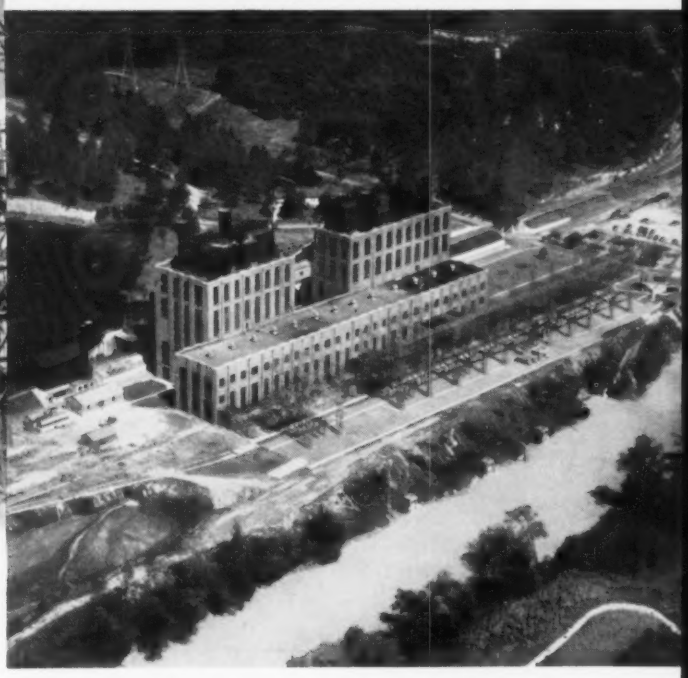
16 Steam Generating Units

CHAPMAN VALVES

do their part to serve the Citizens of Georgia

Yates Plant near Newman, Georgia. Three 100,000 KW and two 125,000 KW steam-electric units in operation.

Plant Atkinson at Atlanta. Four 60,000 KW units in operation.



You'll find 16 generating stations of the Georgia Power Company located throughout that great state. More units are constantly being added. Total capacity of this huge system, existing and under construction, is 1,843,680 kw . . . an extensive service to the citizens of Georgia.

In every one of the 16 generating plants, engineered by Southern Services, Birmingham, Alabama, you'll find Chapman High Pressure Valves playing their part.

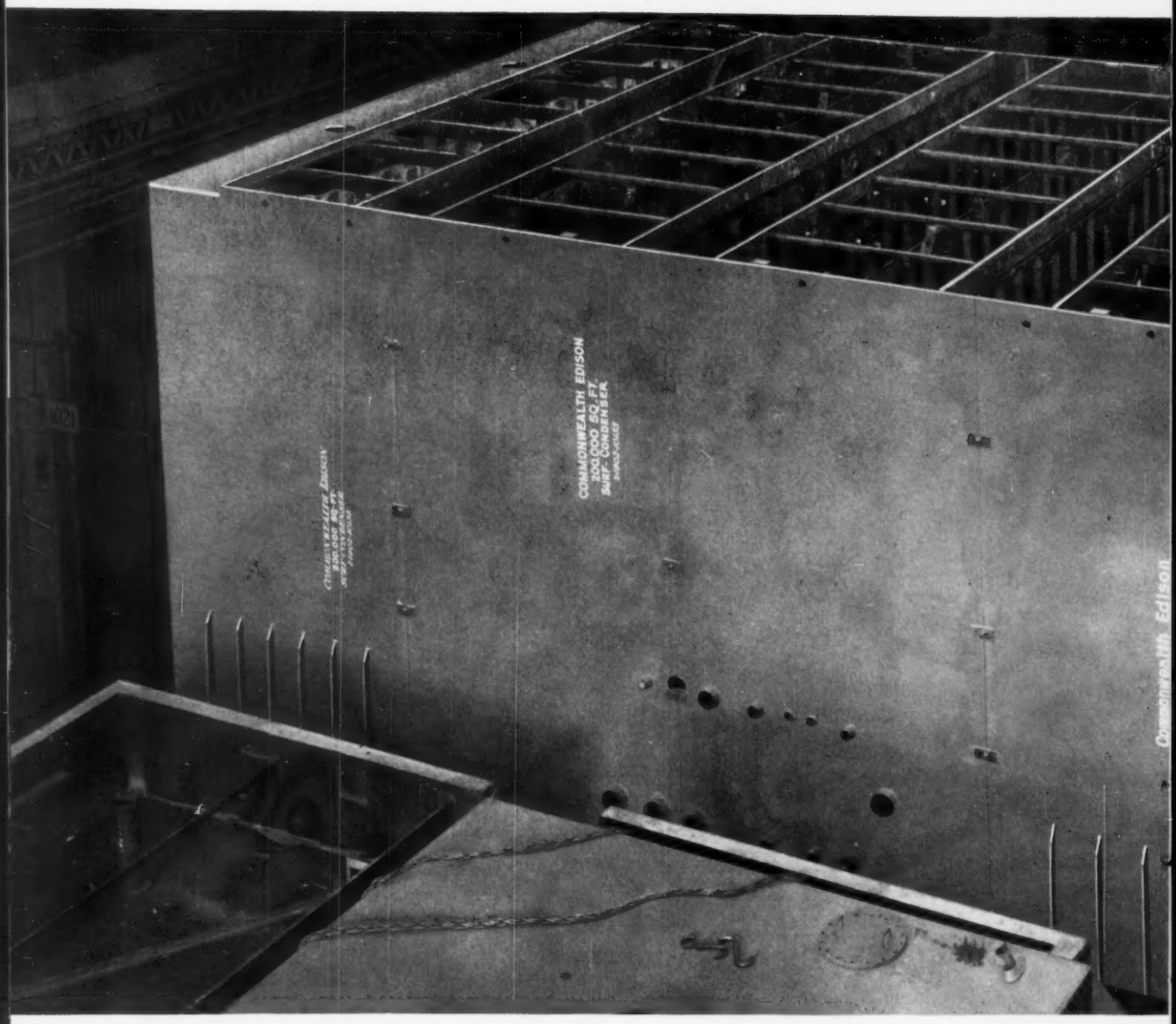
These valves have been selected for many of the major services in each of these plants because they give excellent continuous service under severe operating conditions. They meet the growing demands of increased temperatures and pressures which are requirements for modern power plant operations.

The CHAPMAN *Valve Manufacturing Company*

INDIAN ORCHARD, MASSACHUSETTS

Looking ahead. When it comes to valves, if you are looking ahead to tomorrow's requirements talk with the Company that is looking ahead . . . Chapman Valve Manufacturing Company. Chapman will plan with you, work with you, *produce for you*. Chapman has the engineers, metallurgists, experience and manufacturing facilities to design, develop, build and test the valve equipment you need no matter how tough the requirements. Write and we'll gladly consult with you.

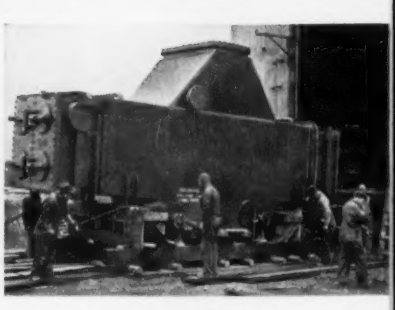
Another Example of Allis-Chalmers



Other Allis-Chalmers Firsts

First condenser with welded tubes to insure against condensate contamination. Welded construction forms a seal with tube sheets to meet new problems created by supercritical pressure, nuclear power, and once-through boiler installations.

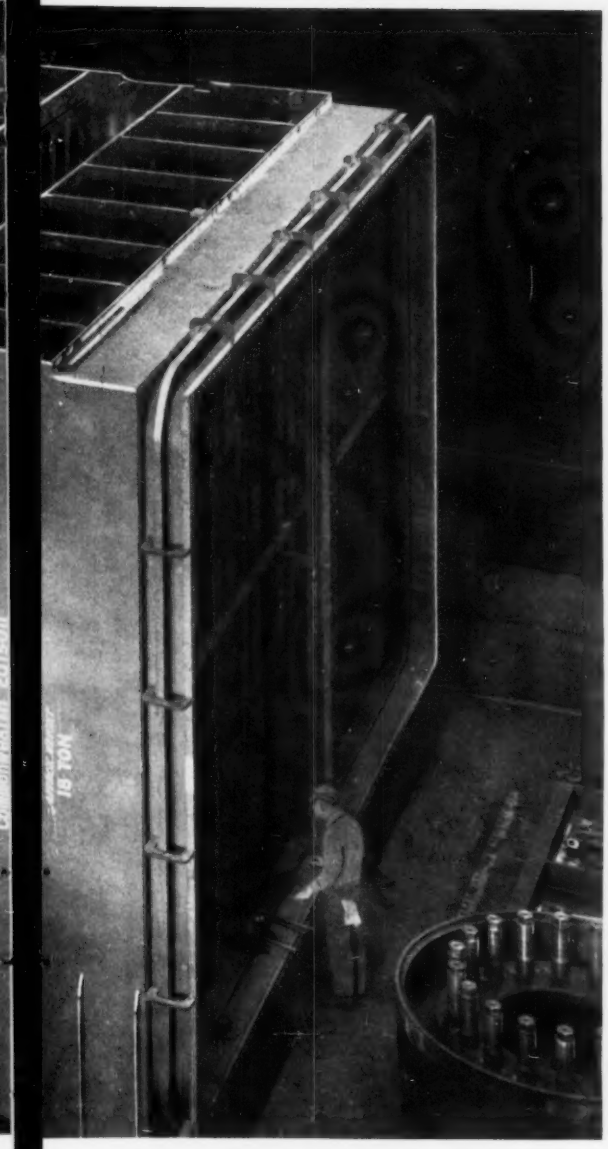
First condenser for first commercial-type nuclear power plant in operation is Allis-Chalmers 5300-sq-ft unit with aluminum tubes, double tube sheets, special leak tightness.



A-C ALLIS CHALMERS

A-5693

Condenser Leadership



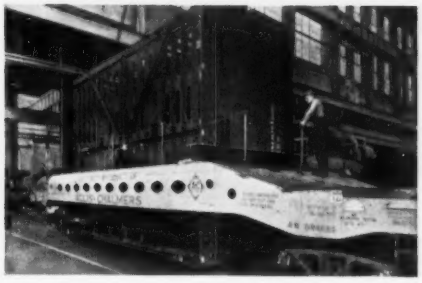
World's Largest Condenser

200,000-square-foot single-shell condenser for Commonwealth Edison

Engineering ability to handle the extraordinary jobs, such as this giant unit, accounts for Allis-Chalmers continued leadership in condenser development. The unit will serve another A-C achievement—a 327 mw steam turbine generator at the utility's Fisk Station.

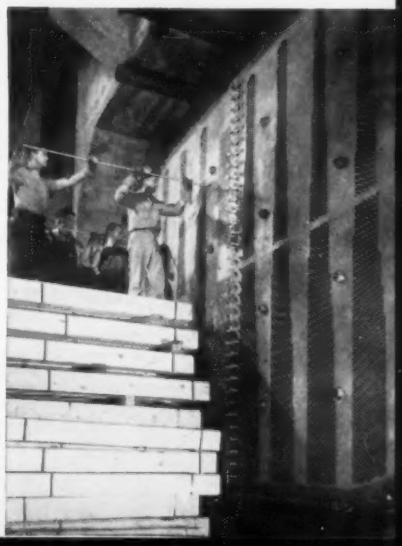
Installation of so large a condenser is not a simple task. However, a unique method devised by A-C is used to minimize erection problems. Complete factory assembly aligns the sections perfectly. Dowel and pull-up blocks are installed at each joint to insure exact alignment when condenser is reassembled in the field. Specially built freight cars permit shipment of the entire shell in only four sections.

For more information on the most advanced developments in condenser engineering, call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.



First with specially built freight cars to accommodate large condenser sections, thereby reducing shipping problems, cutting installation time and costs.

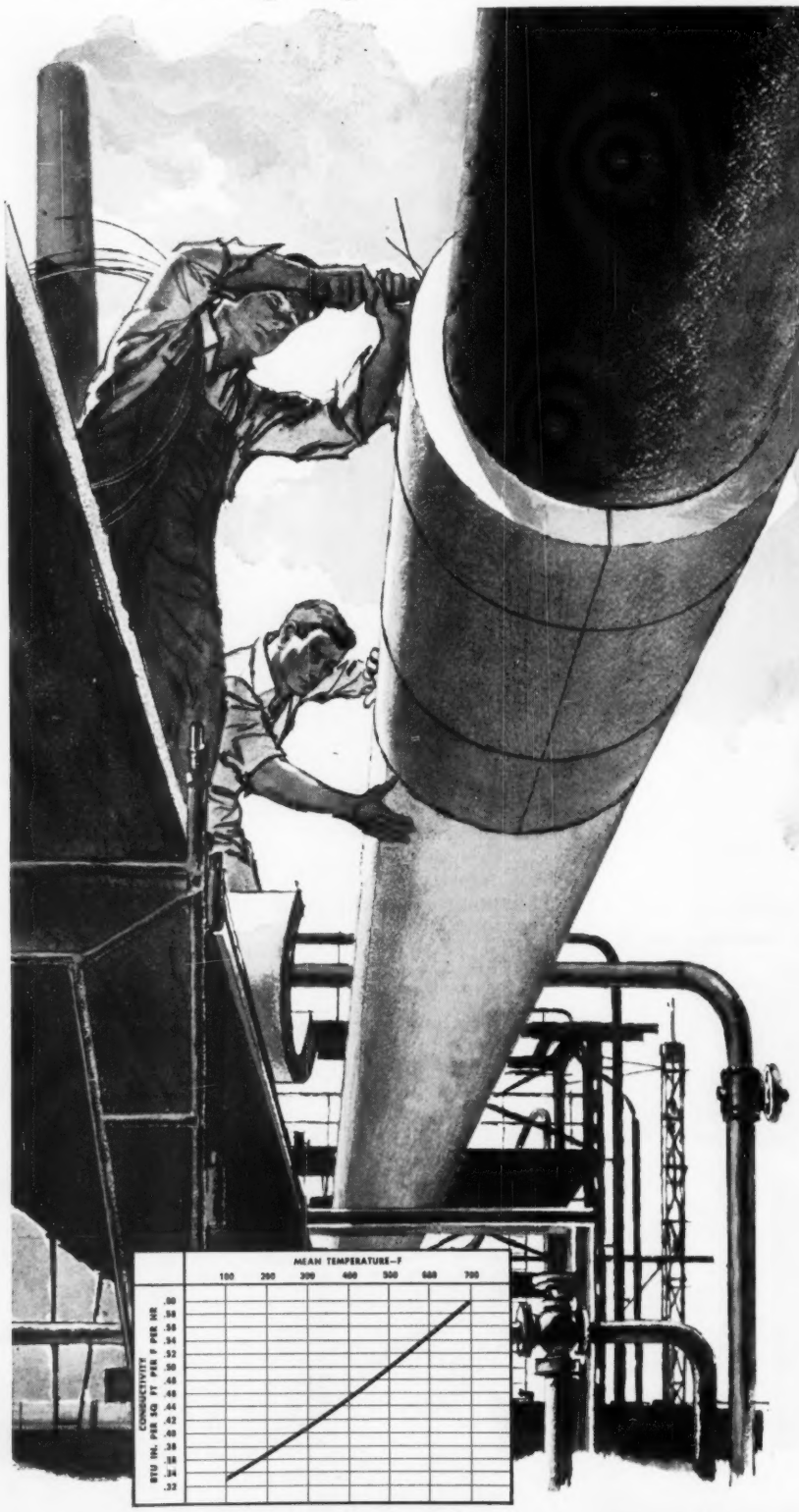
First full-size condenser in public utility to incorporate aluminum tubes. This installation is part of a long-range study that may lead to industry-wide savings.



ALLIS-CHALMERS

In developing THERMOBESTOS Insulation for

J-M at



Low Conductivity. The low thermal conductivity of Thermobestos is best demonstrated in actual service where it makes possible accurate, uniform temperature control, helps reduce fuel costs and contributes materially to operating efficiency.

Not damaged by water. Thermobestos has the moisture resistance outdoor service demands. Soak it in water for one day or 365—and you can still walk on it without damage. Dry it out and Thermobestos is as good as new, with conductivity and structural strength unimpaired.

Johns-Manville

rugged industrial service... indoors and out

research scientists didn't stop top insulating effectiveness...

They added the three physical properties you most wanted— HIGH STRENGTH—LIGHT WEIGHT —MOISTURE RESISTANCE!

THERMOBESTOS® offers the lowest *k* factor of all insulations in general use throughout the power-generation and process industries. For maximum heat control to 1200F it just can't be beat.

Yet top insulating effectiveness is only one reason why Thermobestos is being specified by more and more engineers for power plants, steam-generating stations, and wherever hot piping and equipment must be insulated. For Thermobestos also offers a threefold bonus . . .

. . . Three outstanding physical properties

Thermobestos is 1) strong and rigid. Its hard composition resists crushing and easily withstands unusual service abuse. Yet it is 2) lightweight for easy handling and fast application. And it is 3) highly moisture resistant, remains undamaged even by prolonged wetting.

Quickly, easily applied

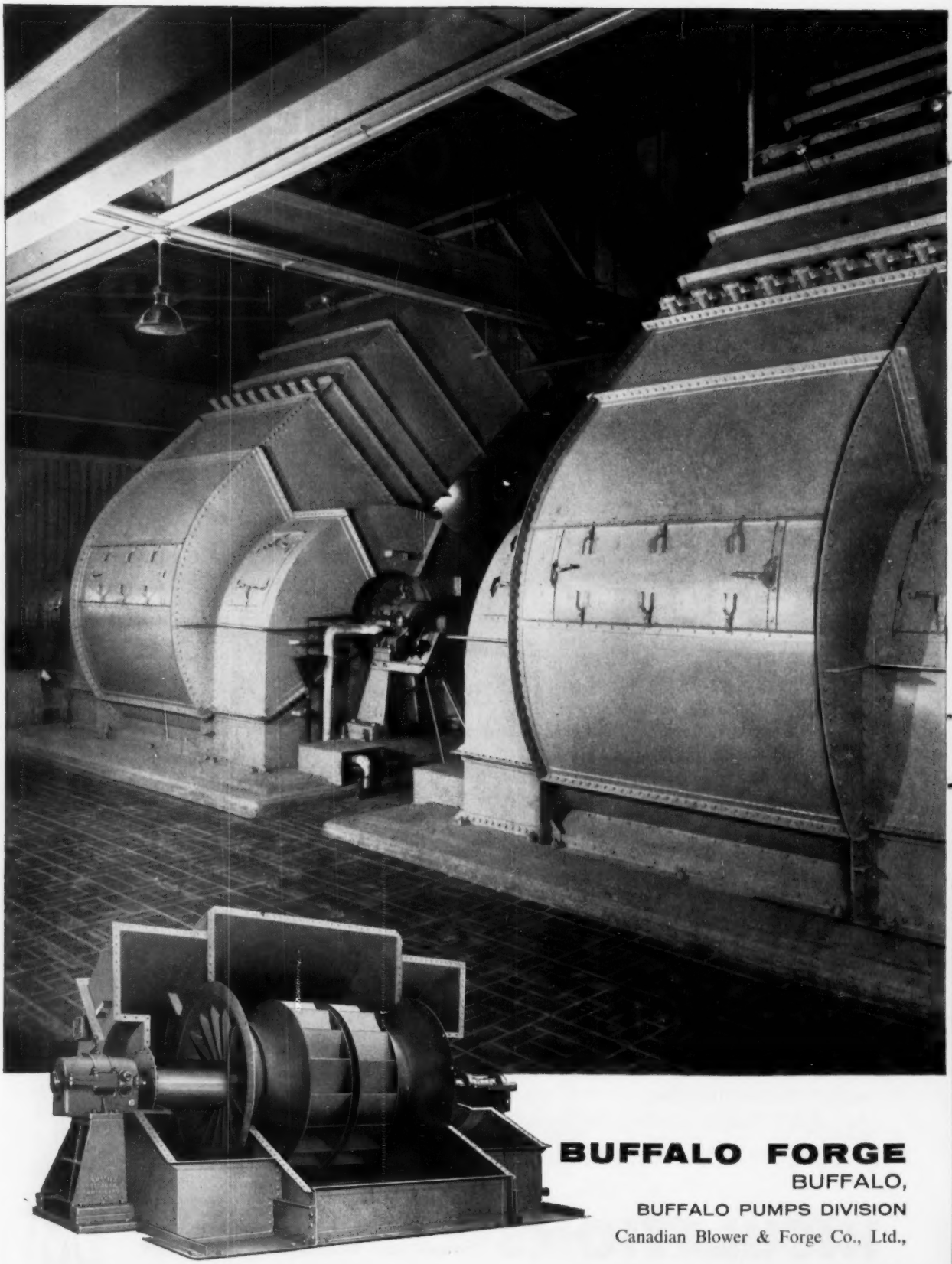
Thermobestos is made from hydrous calcium silicate . . . molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends.

Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints In pipe insulation form, it comes in a complete selection of sizes up to 30″ O. D. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses.

For further information write for your free copy of the 12-page Thermobestos booklet, IN-169A. Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

INSULATIONS FOR LASTING THERMAL EFFICIENCY
MATERIALS · ENGINEERING · APPLICATION

JOHNS-MANVILLE JM PRODUCTS



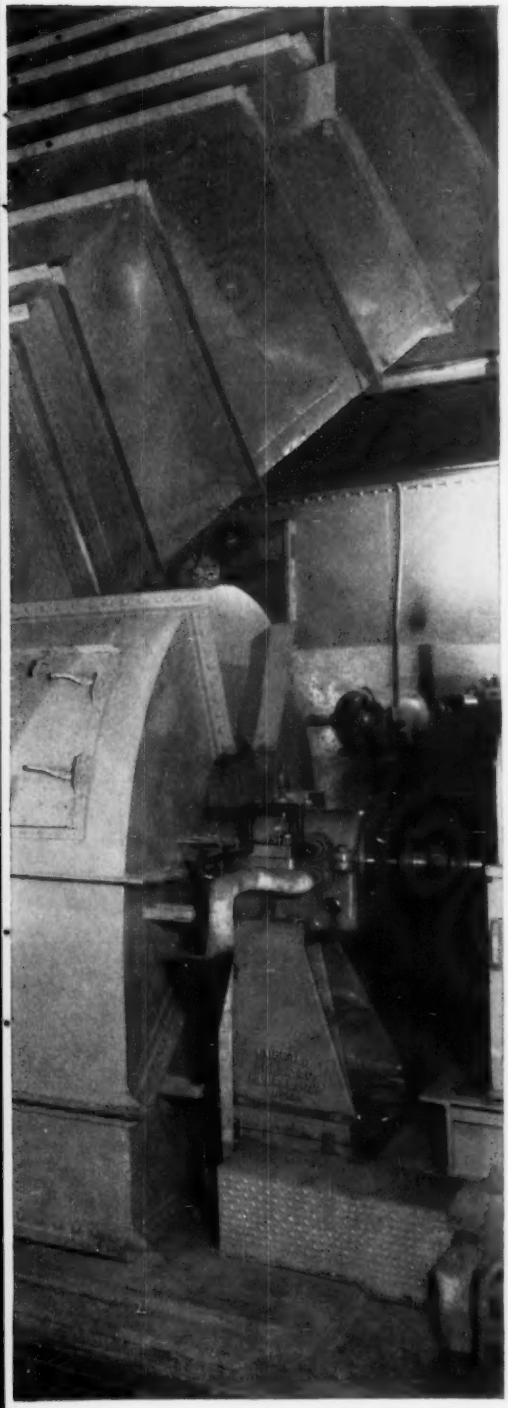
BUFFALO FORGE

BUFFALO,

BUFFALO PUMPS DIVISION

Canadian Blower & Forge Co., Ltd.,

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT



WHY YOU GET MORE AIR PER HORSEPOWER WITH "BUFFALO" AIRFOIL FANS

COMPLETELY STREAMLINED INLET. Wheel flange and matching inlet bell form true half-circle, eliminating turbulence causing flat spots. GENEROUS INLET BOX DIMENSIONS give lower loss through inlet boxes than competitive makes, thus smoother air entry. VARIABLE INLET VANES, when used, are placed well into the inlet throat. Horsepower-reducing spin developed by the vanes is therefore fully utilized by the wheel. WHEEL DESIGN incorporates proper blade passages and air-flow through the wheel, in addition to airfoil blading, to produce maximum efficiencies. SCROLL shape lets air stream from blade passages to the housing channel with greatest ease. DIVERGENT OUTLET provides the optimum of static regain as the air passes from the cut-off, insuring the most efficient performance. Conventional outlet fans have a considerable amount of turbulence at this point.

BUFFALO AIRFOIL FANS ARE BUILT TO:

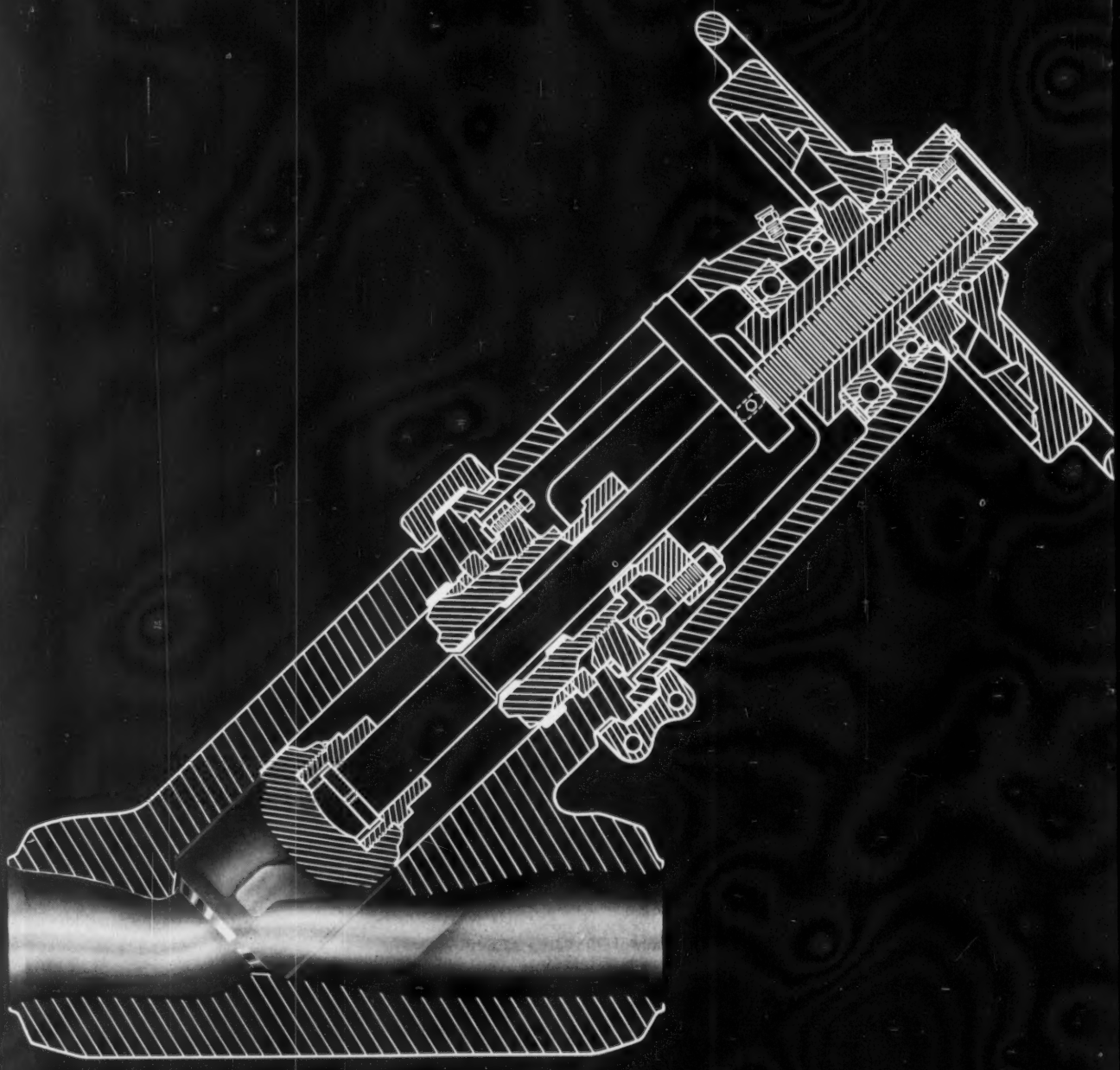
- Capacities in excess of one-half million cfm
- Pressures of 80″ water
- Outlast all other airfoils*

COMPANY
NEW YORK
BUFFALO, N. Y.
Kitchener, Ont.

"Buffalo"

*Every Buffalo Fan brings you the extra benefits of the famous "Q" Factor construction — the built-in QUALITY that assures trouble-free satisfaction and long life.

EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING



NEW EDWARD "FLITE-FLOW" VALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

New Flite-Flow* Valve Cuts Pressure Drop 70%

. . . yet provides full globe valve tightness and repairability

Through basic characteristics of its design, only a hard seat globe-type valve can be depended upon to give drop-tight shutoff under high-pressure, high-temperature conditions. But conventional globe valves also produce serious pressure-drop problems—which intensify in the trend toward larger-capacity, higher-pressure plants with their higher-velocity flow rates.

Briefly stated, this was the problem given to Edward engineers. In their continuing program of valve development, these men had singled out turbulence in the flow path as a key area for study. They charted the effects of re-shaping flow passages . . . of shifting valve seat location . . . of *pre*-shaping the flow as it approaches the seat.

Low turbulence factor

All tests confirmed that total pressure drop was least when turbulence was minimized in the three most critical areas: ahead of, at *and beyond the seat.* In the final design, flow approaching the seat is pre-shaped to provide a special "squirting action" which carries the fluid smoothly across the seat. The downstream side of the passage is shaped to receive this flow and send it on with a minimum of eddy and turbulence.

The net result of years of research and development, Flite-Flow is available in sizes 10" and larger.

The result is Flite-Flow, a globe valve with drop-tight shutoff *and* negligible pressure drop, as shown in the tables below:

FEEDWATER SERVICE

In 500-F, 3000-psi feedwater service on a 1,500,000 lb/hr unit, the following performance of 12-inch valves has been recorded:

Ordinary globe valve ...10-15 lb drop
EDWARD FLITE-FLOW VALVE ...2.1 lb drop
Good gate valve . . . 1.0 lb drop

STEAM SERVICE

In 1050-F, 1900-psi steam service at 800,000 lb/hr through a 12-inch valve, the following performance has been recorded:

Ordinary globe valve...64 lb drop
EDWARD FLITE-FLOW VALVE ...11 lb drop
Good gate valve . . . 2 lb drop

OTHER IMPORTANT FLITE-FLOW FEATURES:

- RESISTANCE TO THERMAL DIFFERENTIALS —a real design and metallurgical achievement.
- REPAIRABILITY OF SEATING SURFACES —while valve is in the line.
- PIPING VERSATILITY —fits any piping plan. Unique design assures accurate guiding of disk whether stem extends up, down or horizontally.
- IMPROVED OPERATING MECHANISMS —manual, pneumatic, electric.
- INTEGRAL SEAT CONSTRUCTION —inlaid stellite seat, machined and lapped in same set-up as body bore for perfect alignment.

EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, East Chicago, Indiana

Represented in Canada by
LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St., W. Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 psi; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T.M. Reg. U.S. Pat. Off.

Telephone

manufacturer calls for coal

Automatic Electric Co. burns coal in new plant because of cost and availability

Modern facilities, modern products, modern fuel—you'll find all three at the new Northlake, Ill., plant of Automatic Electric Co., manufacturing subsidiary of General Telephone. The power house of this communications equipment plant (designed and built by The Austin Company of Cleveland) is as modern and efficient as the manufacturing process itself. The plant required large quantities of economically and reliably produced steam for process work and heating. The fuel selected was *coal*, because of coal's economy and abundant supply. As a result, today Automatic Electric enjoys dependable, low-cost steam.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas, as in the case of Automatic Electric, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send the coupon below for case histories, complete with data sheets. You'll find them informative.

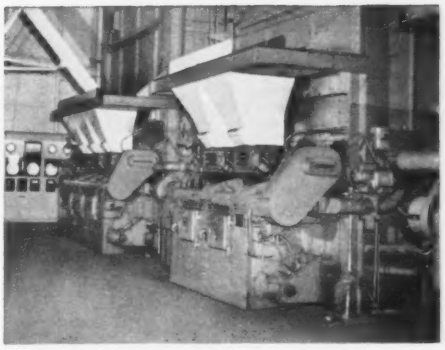
Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

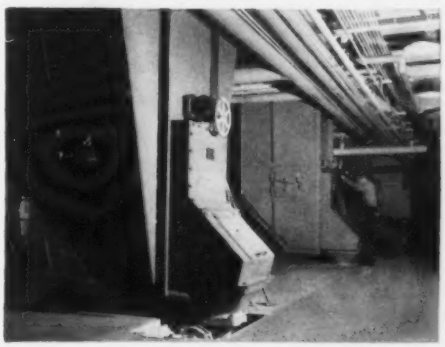
Department P-04

Southern Building • Washington 5, D.C.



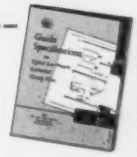
Shown are two of the three Keeler boilers – fired by Detroit Spreader Stokers – in the power plant. At the right is the 22,000 lb/hr boiler. In the background is one of the 50,000 lb/hr boilers. The two sizes allow flexibility in operation for widely varying load requirements.

Control panel by Hays Corporation. This system regulates all operations of the boilers—steam pressure, draft, flue gas temperature, banking periods, etc. —to give complete, automatic control of steam generating operation.



Ash disposal system, by United Conveyor Co., in basement of boiler room. Ash is removed from furnace by Detroit CC grate, drops into hoppers in basement and is taken by vacuum to silo.

The Bituminous Coal Institute now has available a free booklet adaptable for design loads 3,000 to 24,000 EDR steam. This booklet, "Guide Specifications for Typical Low-Pressure Commercial Heating Plant," contains specifications, drawings and tables on all aspects of a typical heating plant. Send in this coupon for your copy.



☐ Guide Specifications Booklet ☐ Case histories on larger plants.

Name_____

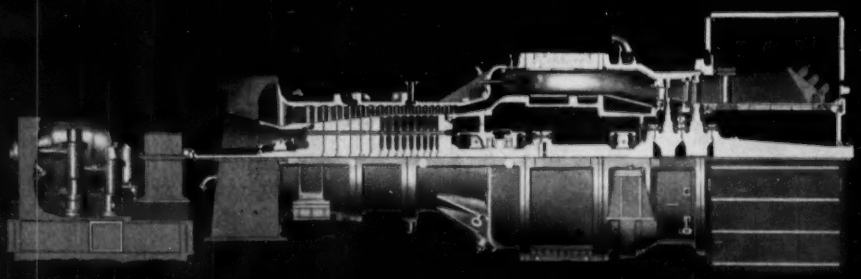
Title_____

Company_____

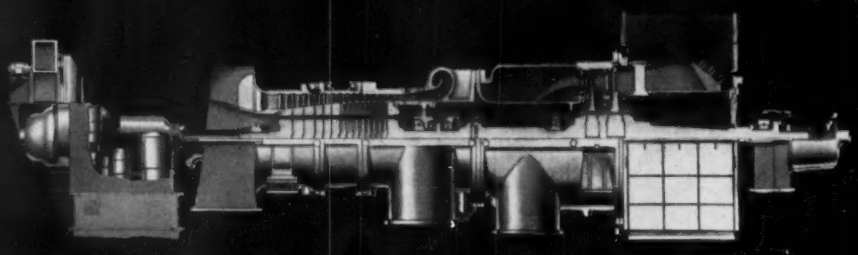
Address_____

City_____ Zone____ State_____

SIMPLE-CYCLE
16,500 KW, 22,500 HP

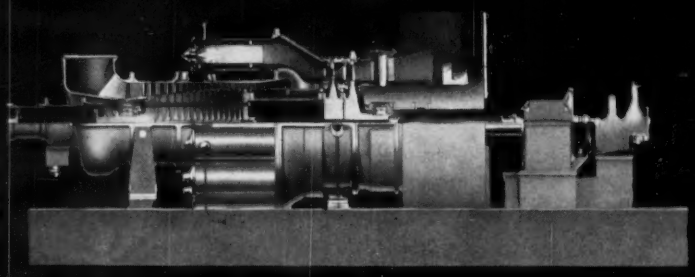


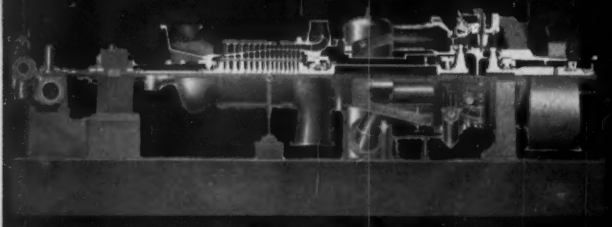
General Electric Gas Turbines Log...



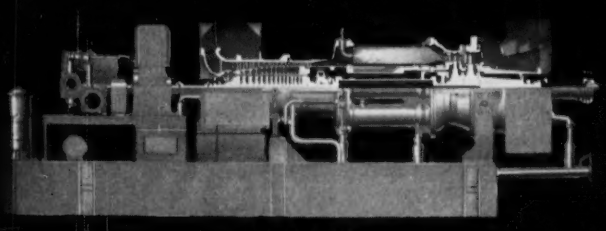
REGENERATIVE-CYCLE
15,200 KW; 20,900 HP

SIMPLE-CYCLE
9,500 KW; 13,400 HP

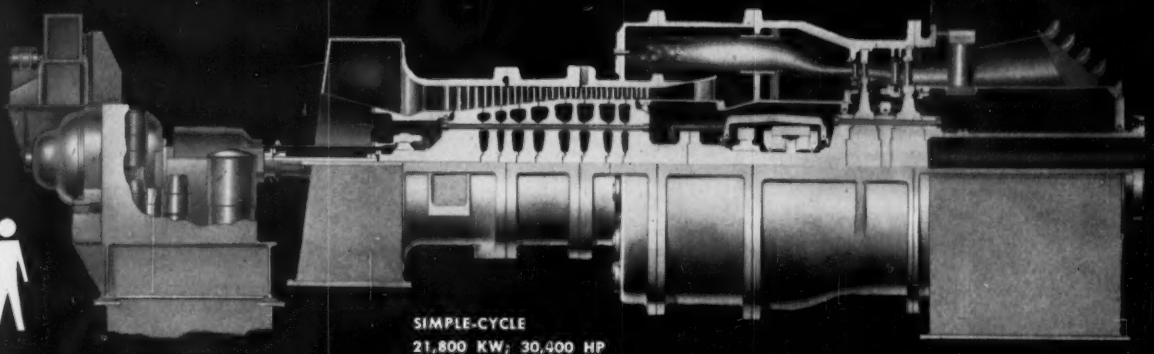




REGENERATIVE-CYCLE
5,400 KW; 7,600 HP



SIMPLE-CYCLE
5,300 KW; 7,500 HP



SIMPLE-CYCLE
21,800 KW; 30,400 HP

OPERATING EXPERIENCE, WIDE RANGE OF RATINGS OFFER NEW OPPORTUNITIES FOR INCREASING USE

Over 2,250,000 Operating Hours

Over two-and-a-quarter-million operating hours recorded by 135 units in a wide variety of applications—this is the unduplicated performance record that has established General Electric gas turbines as increasingly important powermakers.

APPLICATION VERSATILITY is one of the primary reasons for wide gas turbine acceptance. By providing power, exhaust heat, or combustion air for use in process or in combination with steam turbines, these self-contained prime movers are able to satisfy a variety of power requirements. A brief look at the chart on this page shows the varied industries using General Electric gas turbines.

A BROAD RANGE OF RATINGS is now available. Units range from 6,700 to 30,400 horsepower and 4,750 to 21,800 kilowatts. Because gas turbines are more compact than conventional power plants, building requirements are simple and limited space is required.

Proven by operating experience, versatile General Electric gas turbines stand ready—now—for even broader application. Whatever your power, heat or process requirements are, why not get all the facts on this important power plant. For more information, contact your nearest General Electric Apparatus Sales Office or write for GED-3546 (Gas Turbines for Industry), or GED-3603 (Gas Turbines for Electric Utilities), General Electric Company, Section 261-31, Schenectady 5, N. Y.

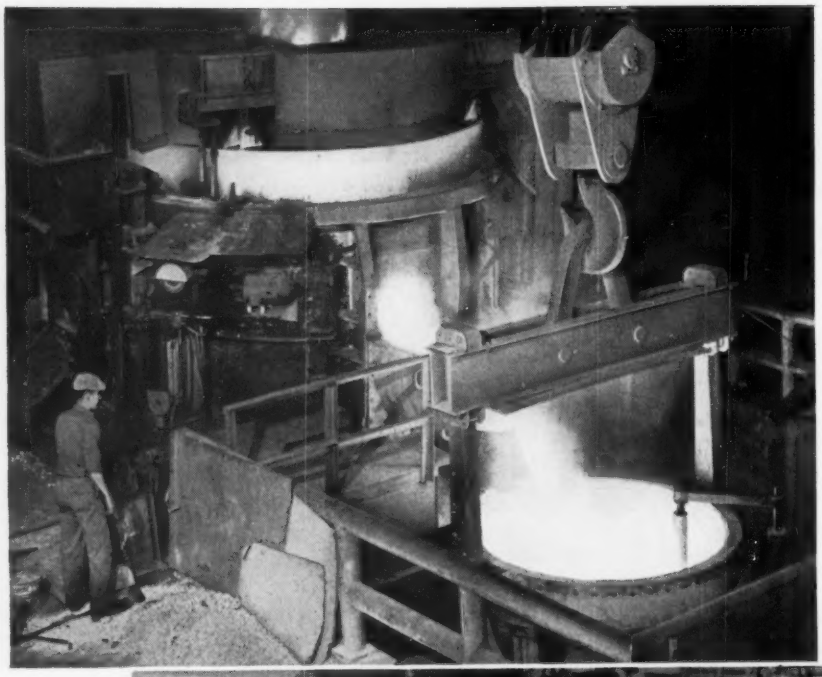
GENERAL ELECTRIC GAS TURBINES POST IMPRESSIVE OPERATING RECORDS IN DIVERSE APPLICATIONS

APPLICATIONS	NUMBER OF UNITS*	TOTAL EQUIVALENT HORSEPOWER*	OPERATING HOURS
GAS AND OIL PIPELINE	88	574,800	1,185,000
LOCOMOTIVE DRIVE	58	462,890	500,000
ELECTRIC UTILITY	31	348,200	200,000
PETROLEUM AND CHEMICAL	20	191,450	50,000
OIL FIELD	16	155,400	300,000
GENERAL INDUSTRIAL (steel, rubber, paper)	5	76,200	10,000
MARINE AND NAVY	2	10,600	5,000
TOTAL	220	1,819,540	2,250,000

*General Electric gas turbines installed and on order as of February, 1958.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Tapping a 50-ton arc furnace at B&W Barberton works.

Rigid quality control is maintained through all phases of production down to final inspection.

Why B&W Hollow Forged Piping Gives Long, Dependable Service

At B&W, quality control of Hollow Forgings is constant from initial melt to final inspection of the finished product. This *integrated* control is a big reason why B&W Hollow Forged Piping is the most practical choice for main steam, reheater, feedwater, and other heavy-duty high-pressure or high-temperature lines.

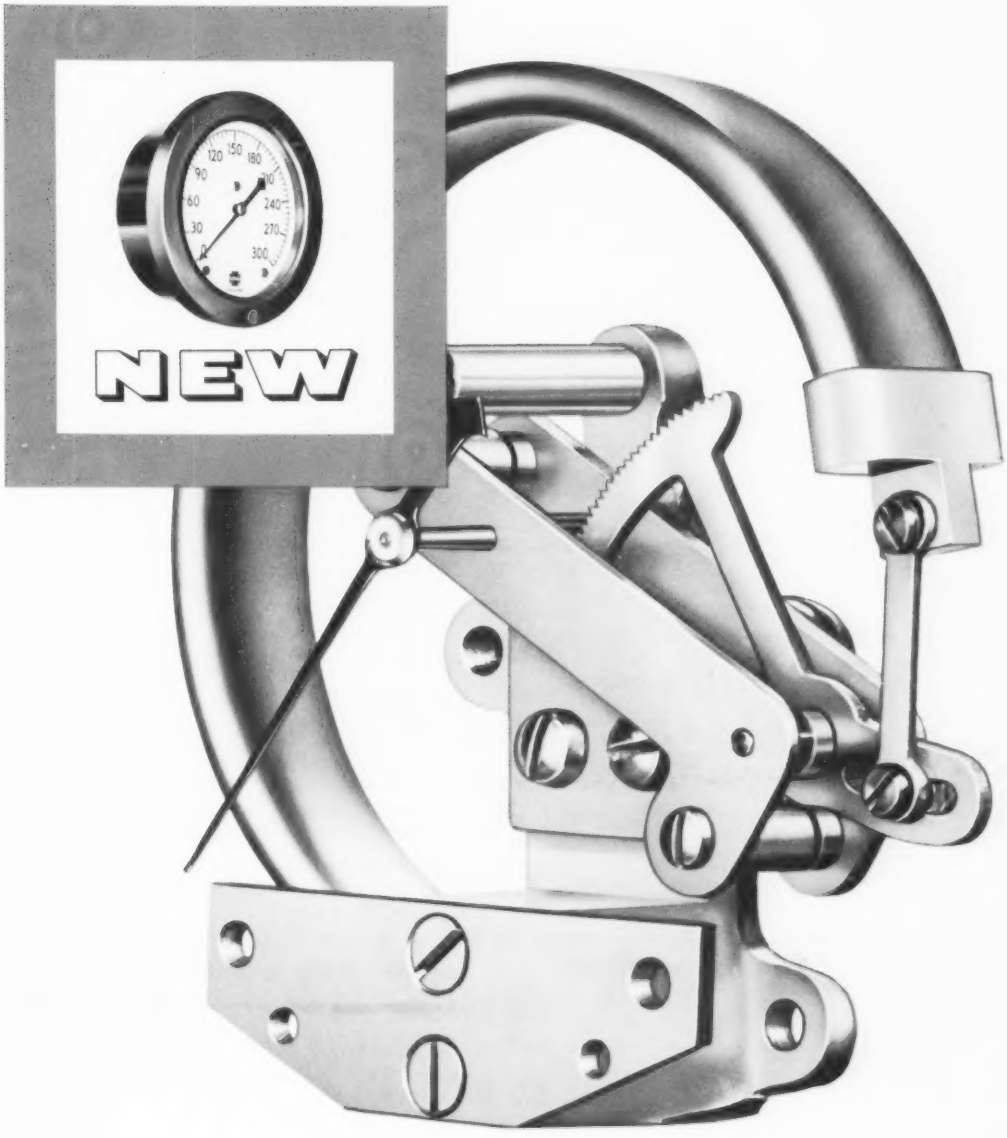
Testing at B&W includes analysis and grain structure examinations—hydrostatic test—and ultrasonic test as standard procedure. What's more, B&W machines the outside surface of every forging, to assure good appearance and ease of fabrication.

B&W Hollow Forged Piping is available in a wide range of sizes, in carbon, alloy and stainless grades, and is made to ASTM specifications. There is a size and grade close to your optimum design requirements. For more about how B&W Hollow Forgings meet your needs best, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

S-475-HF

BABCOCK & WILCOX

BOILER DIVISION



THE USG "A" LINE—Now, from the nation's largest gauge maker, a complete new line of quality gauges—guaranteed to be the "best buy" on the market in their class!

The new "A" Line gauges are the modern counterparts of USG's utility line, the 500 Series, with many important design improvements.

MEETS A.S.A. GRADE A STANDARDS — Guaranteed accurate within 1% of scale range for middle (working) half of scale. More than adequate for a broad range of industrial applications.

ALUMINUM CASES—Lightweight and corrosion-resistant. Case styles include front flange with hinged cover. Other case materials and a variety of modern designs available.

COMPLETELY REDESIGNED MOVEMENTS—New precision-constructed movements include deep bushed brass and all stainless steel, as well as nylon-stainless steel.

STURDY BOURDON TUBES—Choice of Bourdon tubes, quality-controlled by USG . . . designed for longer life and maximum stability in service.

OPTIONAL EXTRAS—Among numerous options, you can have silver soldered connections for high temperature service . . . non-shatter and plastic glass covers . . . chrome plated rings.

PRICE, IT'S LOW!—You have to *see* the new "A" Line gauges to believe all the quality features they offer at amazingly low costs. Ask your U. S. Gauge distributor for a demonstration today, or write for a copy of new Catalog 305.

UNITED STATES GAUGE

DIVISION OF AMERICAN MACHINE AND METALS, INC., SELLERSVILLE, PA.

USG

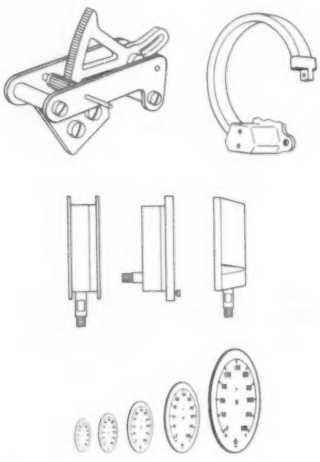
if you are looking for

ACCURACY
QUALITY FEATURES
LONG LIFE
EASY MAINTENANCE
LOW COST
GOOD DELIVERIES

SEEING IS BELIEVING

Call your USG Distributor for a personal demonstration of these features

ACCURACY—Guaranteed accuracy within 1% of range for middle half of scale, where readings are generally taken (and 1½% of scale for the remainder). Designed specifically for the thousands of industrial applications which do not require the higher accuracy of Grade AA gauges like USG's SUPERGAUGE (guaranteed within ½ of 1% of scale).



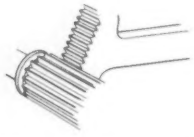
QUALITY FEATURES—You can choose from a variety of design options, many of which are quality components of the SUPERGAUGE line, to meet your application needs. For example:

IN MOVEMENTS: Available movements, so important to sustained performance, include: corrosion-resistant brass . . . heavy-duty, deep bushed brass with stainless steel arbors and pinions . . . all stainless steel . . . or the SUPERGAUGE ARC-LOC (nylon-stainless steel) movement.

IN BOURDON TUBES: You can choose from such types as phosphor bronze, 403 or 316 stainless steel, with female tip construction and flat tube design. Largest possible size of tube for each case size provides extra strength for maximum life and stability of measurement.

IN CASE DESIGNS: Standard aluminum cases have back or front flange for front of board or panel mounting. Other case materials include cast iron, brass and phenolic resin. Front rings can be peaked (slip or threaded) or hinged.

IN SIZES AND RANGES: Dial sizes are 3½, 4½, 6, 8½, and 12 inches. Pressure ranges go up to 10,000 psi gauge and down to 30 in. Hg vacuum. Compound ranges also available.



LONG LIFE—Design improvements embodied in the "A" Line are based upon U. S. Gauge's 50 years of experience in the making of pressure gauges. Proper selection of available components can assure you long service life through such features as precision "generated" gear teeth for minimum friction and wear . . . extra deep bushed movements where needed . . . corrosion-resistant parts.

EASY MAINTENANCE—Socket, tube, tip, movement, dial, and pointer are removable as one unit.* This "Mono-Unit" construction eliminates possible pointer shift due to stresses at gauge connection . . . makes it easy to remove entire gauge internals for inspection and recalibration. Calibration adjustments are simple and positive.

*Except 3½-inch size

Find Your Nearest Agent In The 'Yellow Pages'

For NEW CATALOG 305 "Pressure Gauges for General Industry" call your nearest USG Distributor . . . or write to us direct.

UNITED STATES GAUGE

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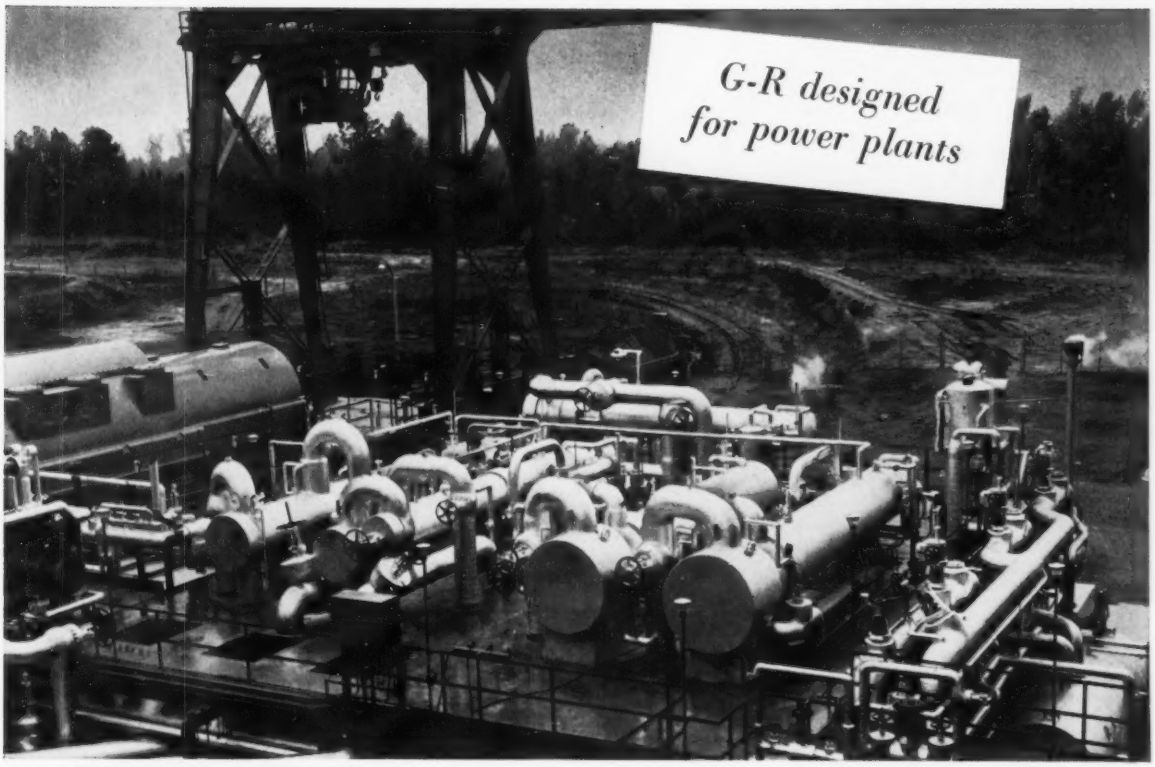
USG



Three reasons for specifying G-R Feedwater Heaters

SERVICE

Griscom-Russell service—from the design stage through installation to follow-up—is known to be the most complete in the industry. You *know* G-R Heaters will perform properly.

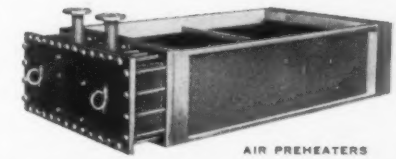
DESIGN AND CONSTRUCTION

90 years of experience plus extensive research contribute to the many *important* features that can be found in G-R Feedwater Heaters. Bundles are easily removable, steam baffling is designed for low pressure losses and efficient distribution, condensate drainage is complete without surging, capacity is guaranteed. These and other features provide the reliable operation and low maintenance that are inherent in G-R designs.

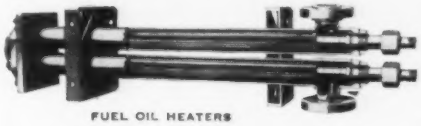
COST

Always competitive, frequently the lowest, always the most economical because you get more in service and lowered operating costs.

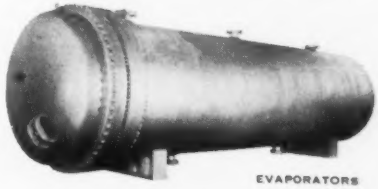
Send for Griscom-Russell Bulletin 300.



AIR PREHEATERS



FUEL OIL HEATERS



EVAPORATORS

G-R Designs for Power Generation

Evaporators • Air Preheaters • Fuel Oil Heaters • Storage Tank Oil Heaters • Drain Coolers • Feedwater Heaters • Transformer Oil Coolers • Generator Coolers • Lubricating Oil Coolers

HEAT EXCHANGE EQUIPMENT

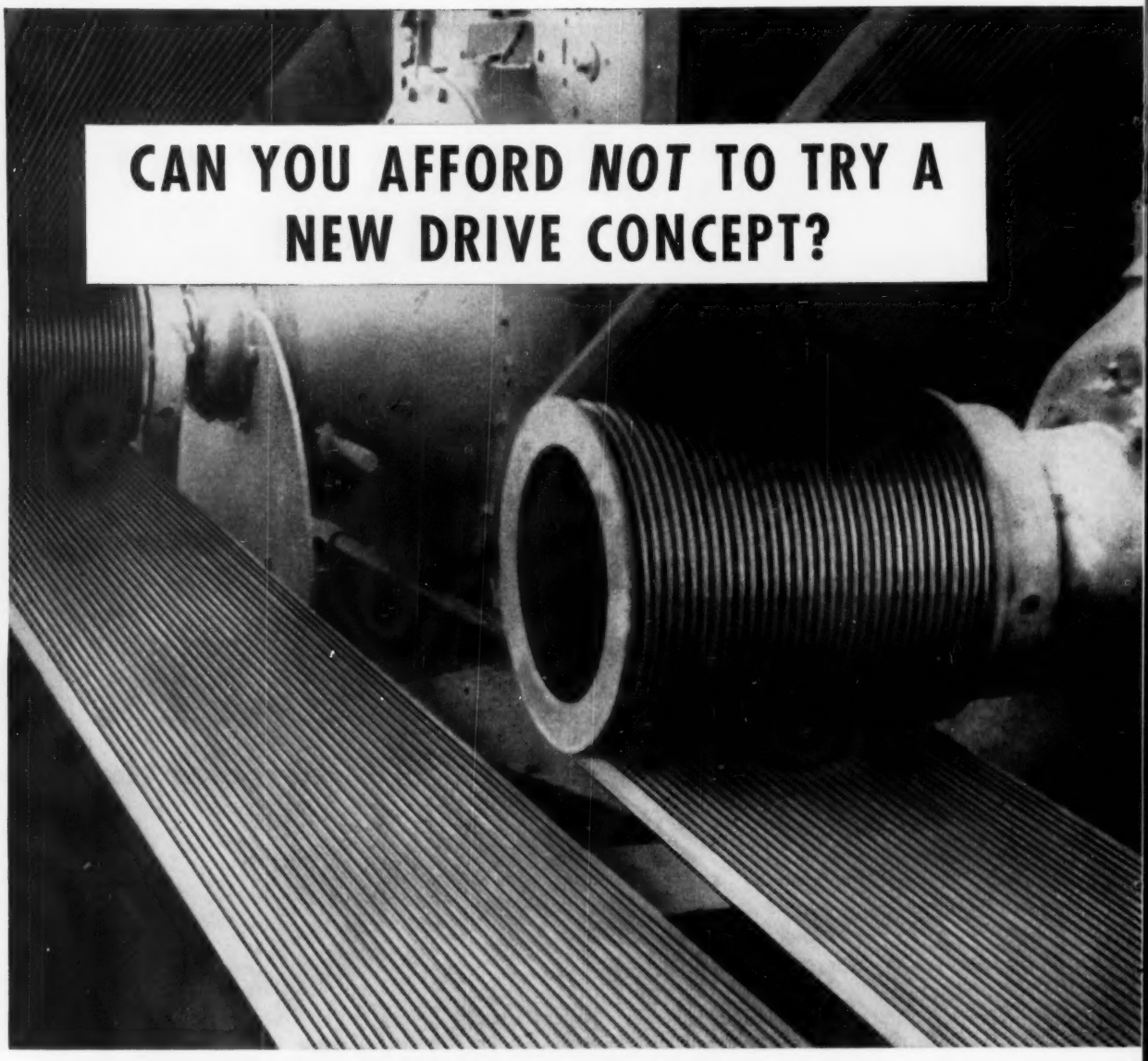
FOR THE POWER INDUSTRY

Griscom-Russell | GENERAL PRECISION EQUIPMENT CORPORATION

THE GRISCOM-RUSSELL COMPANY • MASSILLON, OHIO

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

GR-379



R/M Poly-V® Drive Delivers More Power in Less Space

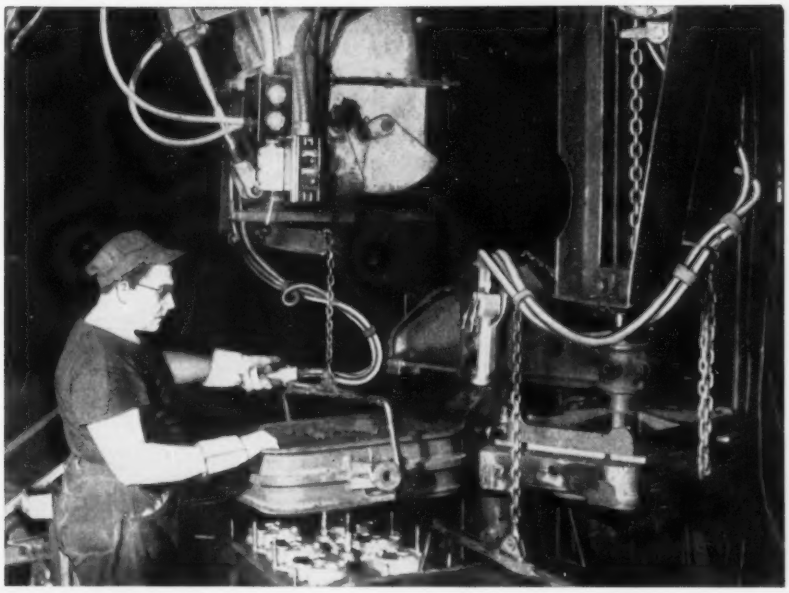
. . . "More Use ~~per~~ for Your Dollar"

Patented new design gives Poly-V Drive up to 50% more power capacity than a conventional V-drive of equal width . . . equal power in as little as 2/3 the width! Single unit V-ribbed belt permits *narrower drive sheaves . . . less shaft overhang . . . less drive weight.* Drive features add up to a new standard in trouble-free drive performance never before possible for heavy duty power driven equipment.

- Eliminates Multiple-Belt "Length Matching" Problems
- Maintains *Constant* Speed Ratios — *No* Load to *Full* Load
- Less wear on belt and sheaves
- *Two* Belt Cross Sections Meet *Every* Heavy Duty Power Requirement
- Reduces Belt *and* Sheave Inventories to a Minimum

Investigate advantages of *new* Poly-V* Drive for your application. Write for Bulletin #6638 . . . or discuss your requirements with an R/M representative.

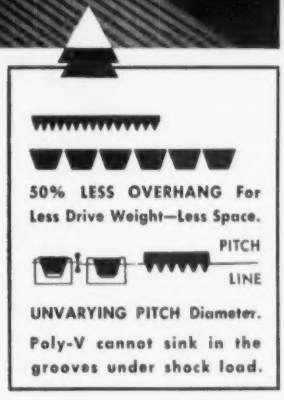
*Poly-V is a registered Raybestos-Manhattan Trademark.



ALLFLEX HOSE — First hose of its type for all-purpose use with air, water, oil, gases—even mild chemicals. Strong, yet light and kinkless. Flexible, has no pre-set twist—coils and uncoils *in any direction*. Write for Bulletin #7075.

RAY-MAN CONVEYOR BELT — Double compensation relieves stress of outer plies, assures longer life for handling bulk materials. Tough, flexible, resists gouging and tearing. High fastener holding ability. Types available for heat, oil, static resistant use, package and table-top installations. Write for bulletins.

RM816


50% LESS OVERHANG For Less Drive Weight—Less Space.
PITCH
LINE
UNVARYING PITCH Diameter.
Poly-V cannot sink in the grooves under shock load.

BELTS • HOSE • ROLL COVERING • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

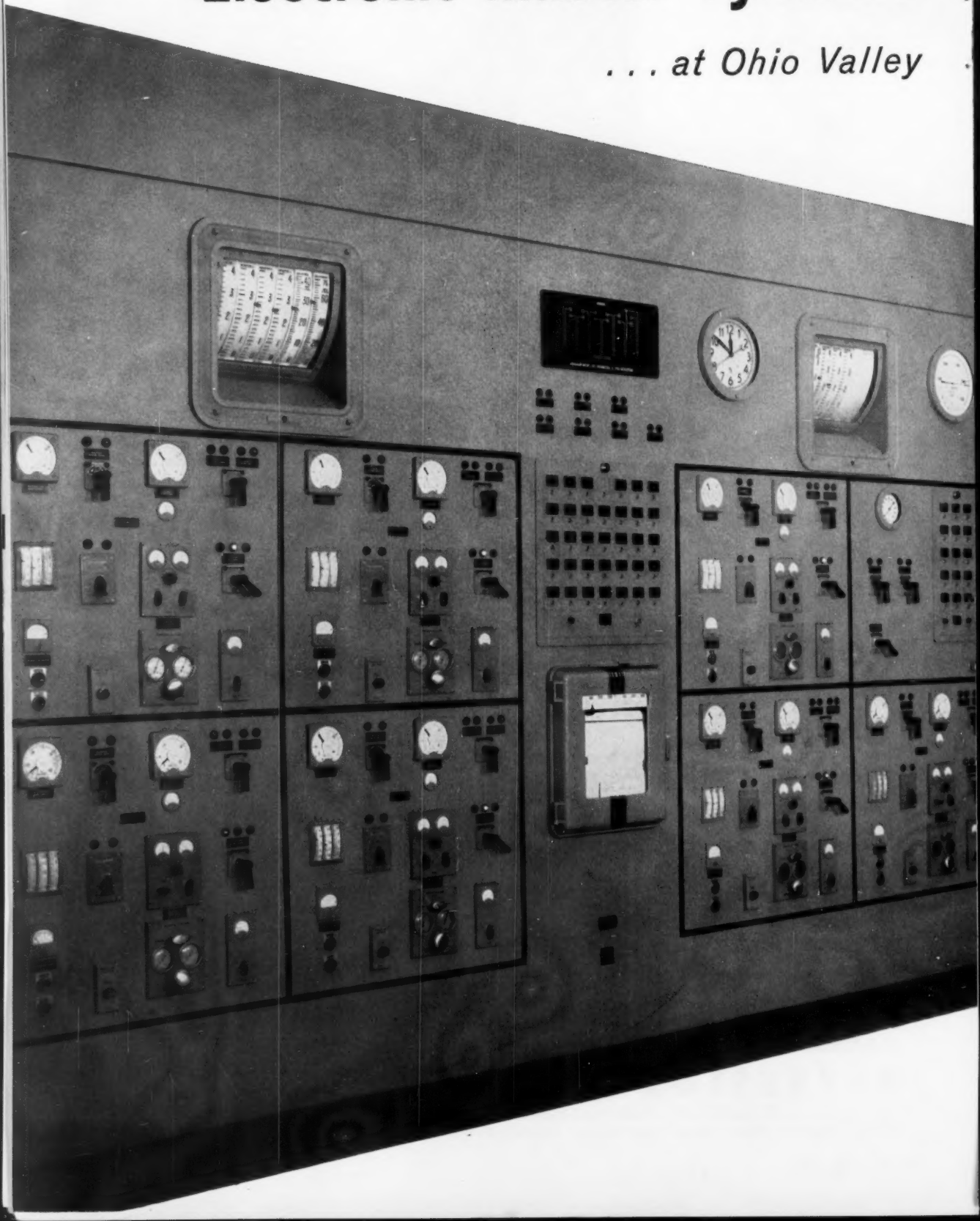
RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

ANOTHER REPUBLIC ACHIEVEMENT!

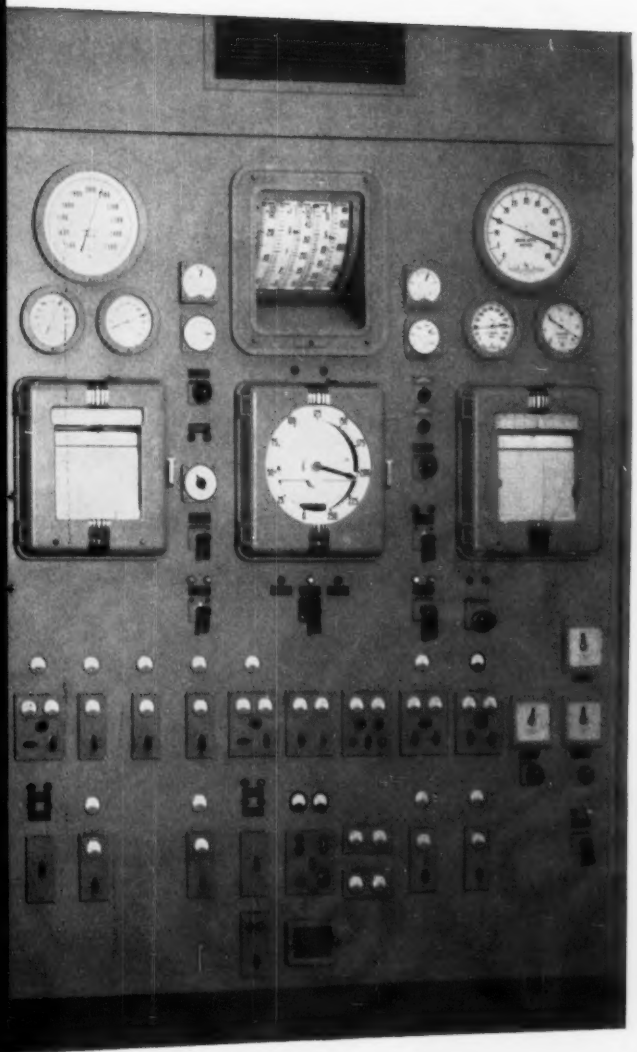
Electronic Master Systems

. . . at Ohio Valley



Control Five 1,400,000 lb/hr. Boilers

Electric Corporation's Kyger Creek Power Plant



One of Kyger Creek's five Republic control centers. An Electronic Master operates to provide electric signals for pneumatic power positioners on 7 coal pulverizers, 2 F. D. fans and 2 I. D. fans on each boiler.

Five large boilers in this plant produce a million kilowatts for our nation's atomic energy program. Multiple components on each boiler must work simultaneously as a single unit, in order to operate at maximum efficiency under all loads. A Republic *load-sensing* combustion control system with an Electronic Master regulates all these inter-related functions . . . counters every fluctuation in steam flow with corrected fuel and air flow settings without waiting for variations in steam pressure. An integral *pressure* control system makes final corrections in control signals (if necessary) to hold steam pressure constant.

Republic's experience with plants of all sizes, all pressure and temperature ratings, and all load characteristics is your best guarantee of getting all the premium performance built into your major equipment. A technically-trained, thoroughly experienced Republic Sales Engineer is ready to discuss your instrument and control problems. Republic sales offices are located in principal cities throughout the country.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

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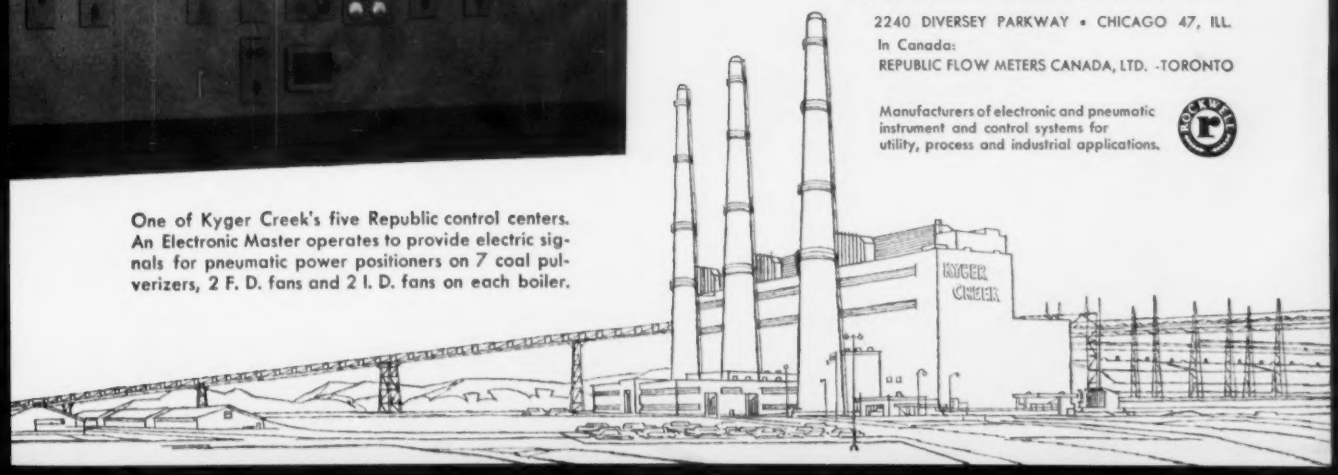
In Canada:
REPUBLIC FLOW METERS CANADA, LTD. -TORONTO

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.



for every temperature range—
for every operating condition

Carey

SERVICE-PROVED INSULATIONS

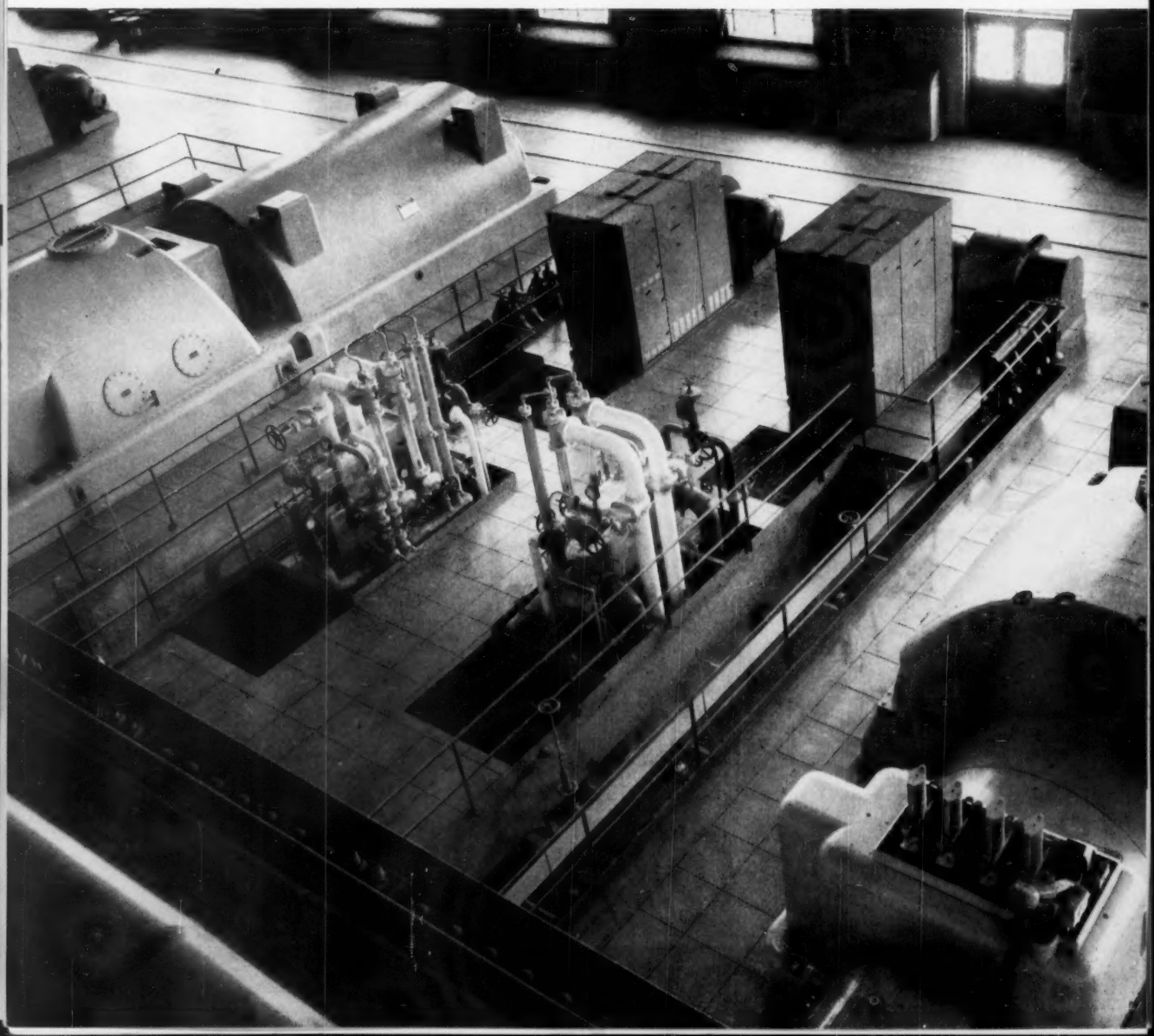
Service Report on Carey Insulations at:

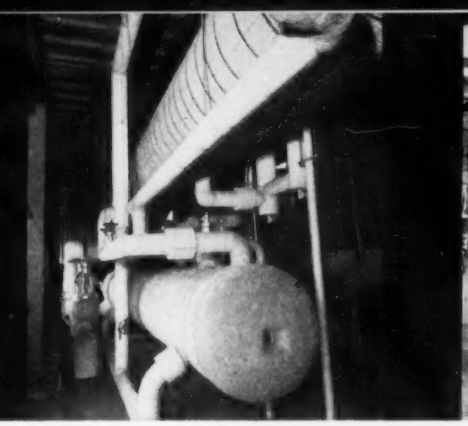
INDIANAPOLIS POWER & LIGHT COMPANY

White River Generating Station, Campbells, Indiana

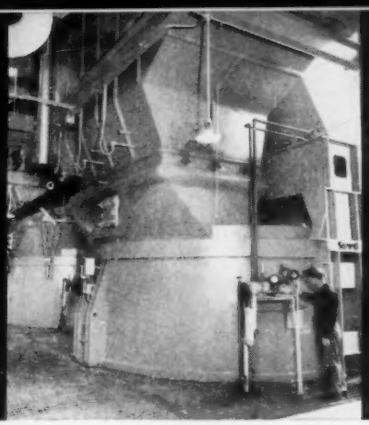
IP&L's White River Generating Station is the largest of the company's five plants. Between them, they supply power throughout 528 square miles of central Indiana. The White River installation alone has a top capability of 376,000 kilowatts and is the main source of power for the sprawling Indianapolis metropolitan area. The last of the plant's six units was completed in October of 1956. Total cost for all units was $51,000,000.

Lower shrinkage, greater moisture resistance make **Carey alltemp**





Carey Alltemp (inner layer) and 85% Magnesia (outer layer) are used on these high pressure heaters and connecting piping. Operating temperatures: 800°-1000°F.



IP&L employee Charles Bass checks pump which propels oil through lubrication system on air-preheater. Carey Alltemp-85% Magnesia combination used on preheater and gas ducts.

and 85% magnesia perform best "under pressure"

White River Generating Station's six boilers are capable of producing over 3 million pounds of steam per hour. Firebox temperatures inside the boilers run as high as 2400°F., and pipe temperatures often exceed 1000°F. This really puts the pressure on Carey Alltemp and 85% Magnesia insulation which cover a large part of the plant's 55 miles of piping. Here are a few of the factors which help these Carey insulation products perform better under the toughest possible operating conditions:

Less Shrinkage — At high temperatures, Carey Alltemp has less than one-half the shrinkage of competitive insulation products. Percentage of heat loss is directly affected by percentage of shrinkage —less heat loss, greater insulating efficiency.

Better Balance — Operating temperatures at White River range from 100° to 1000°F. where Carey Alltemp and 85% Magnesia are used. These products retain their thermal efficiency over this complete temperature range, with only a slight variance in conductivity.

Greater Resistance to moisture, caustics, vibration and shock. Won't shatter or change shape. (Carey Alltemp and 85% Magnesia are easy to cut and fit, too—save application time and costs!)

At IP &L's White River Station, Carey products are meeting a wide variety of heat insulation requirements. They've been on the job since the plant's first unit was constructed in 1948. Repeat orders on subsequent units furnish unmistakable proof of Carey's performance "under pressure".

◀ Auxiliary steam piping at IP&L's White River plant insulated with a combination covering of Carey Alltemp and 85% Magnesia. Operating temperature: 1000°F.

Better Products for Industry Since 1873

THE PHILIP CAREY MFG. COMPANY

Lockland, Cincinnati 15, Ohio

The physical characteristics of Carey insulation products are measured and tested with scientific precision by Mellon Institute of Industrial Research, Pittsburgh, Pa. This is your assurance of the accuracy of Carey product specifications. Mail coupon for literature and sample specifications, or write for the name of your Carey Industrial Sales Engineer.

THE PHILIP CAREY MFG. COMPANY, Dept. P-48
Lockland, Cincinnati 15, Ohio

Please send literature and sample specifications on

☐ Alltemp ☐ 85% Magnesia

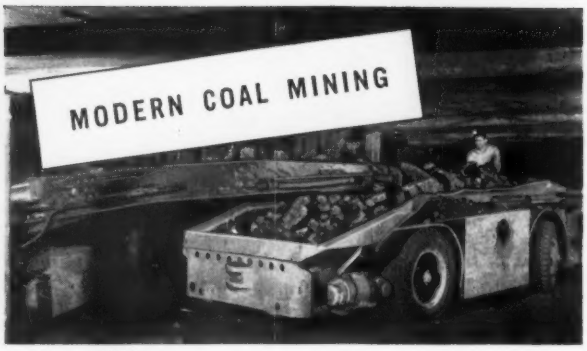
☐ Please have your Industrial Sales Engineer call.

NAME_____ TITLE_____

FIRM NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



+

+

=

LOW COST STEAM GENERATION

They all add up!

The world's finest all-purpose Bituminous Coal comes from mines located along the Norfolk and Western. This coal is mined by the most modern methods and is virtually "tailored" in modern preparation plants to meet the varying needs of industry.

The sum of these advantages, plus dependable N&W transportation and your own modern steam operation, equals what every economy-minded coal user strives for — low cost steam generation!

N & W coal bureaus where competent coal counseling service is available without obligation:

ROANOKE
N&W Coal Traffic Dept.
Telephone Diamond 4-1451,
Ext. 313, 423, 249, 732
Roanoke, Virginia

BOSTON
833 Chamber of Commerce Building
Telephone Liberty 2-2229
Boston 10, Massachusetts

CHICAGO
Room 604,
208 South LaSalle Street
Telephone RAndolph 6-4634
Chicago 4, Illinois

CINCINNATI
913 Dixie Terminal Building
Telephone DUnbar 1-1325
Cincinnati 2, Ohio

CLEVELAND
Room 722
The Illuminating Building
Telephone MAin 1-7960
Cleveland 13, Ohio

DETROIT
1907 Book Building
Telephone WOodward 1-2340 or
1-2341
Detroit 26, Michigan

ST. LOUIS
2059 Railway Exchange Bldg.
Telephone MAin 1-1180
St. Louis 1, Missouri

WINSTON-SALEM
1105 Reynolds Building
Telephone PArk 2-7116
Winston-Salem 1, North Carolina

Norfolk and Western RAILWAY

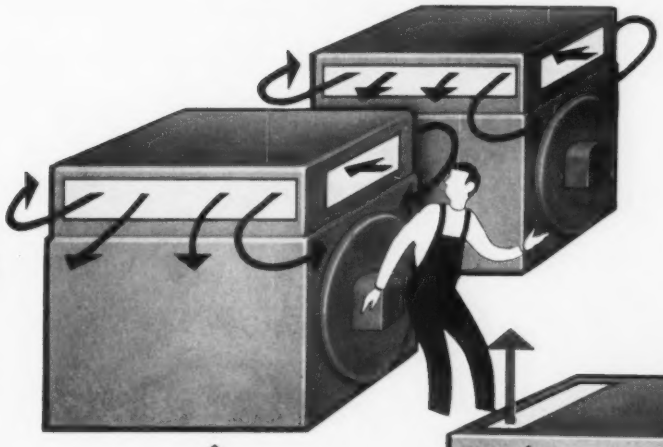
CARRIER OF FUEL SATISFACTION

How would YOU cool a boiler feed pump motor?

"Power plant engineers have suggested several big improvements in the conventional BF pump motor design. For a long time BF pump motors just weren't nice to be near. Now you have another (and we think better) motor design to choose from."—E. H. Jernberg, Chief E-M Mechanical Engineer.

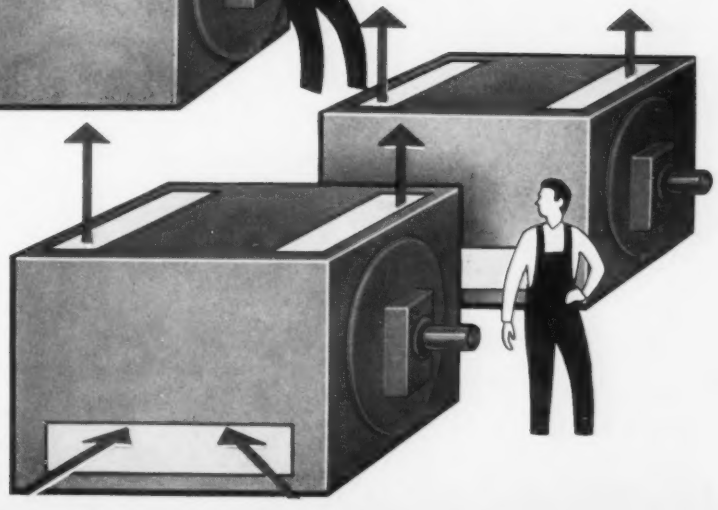
this way?

(HOT AIR GOES 'ROUND AND 'ROUND)



or this way?

(HOT AIR GOES "UP THE STACK")

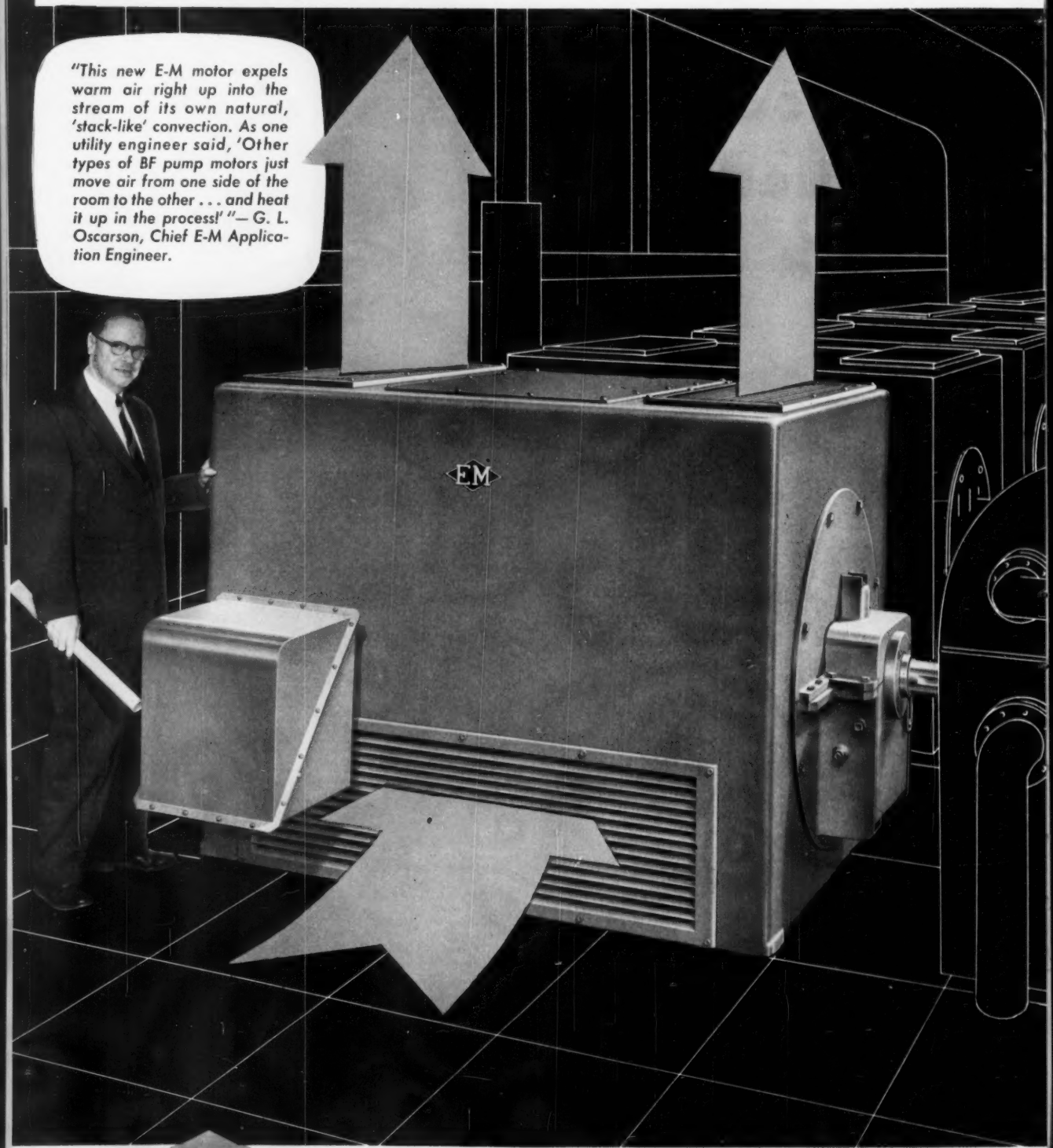


TURN PAGE FOR AN EXCITING NEW CONCEPT IN MOTOR COOLING

Power plant engineers asked for it!

New Straight-Up-Ventilated

"This new E-M motor expels warm air right up into the stream of its own natural, 'stack-like' convection. As one utility engineer said, 'Other types of BF pump motors just move air from one side of the room to the other . . . and heat it up in the process!' "— G. L. Oscarson, Chief E-M Application Engineer.



E-M

1300-TPA-2197

ELECTRIC MACHINERY

Builders of the new pump motor

E-M *designed it! Here it is! The...*

Boiler Feed Pump Motor

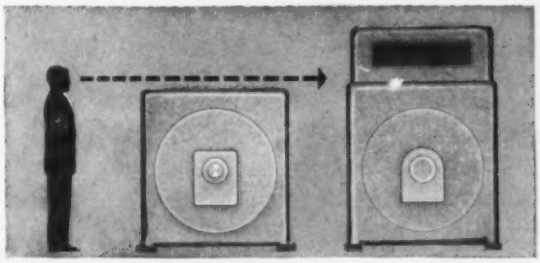
Blows warm air straight up and away!

It has FOUR GREAT NEW FEATURES you've always wanted:

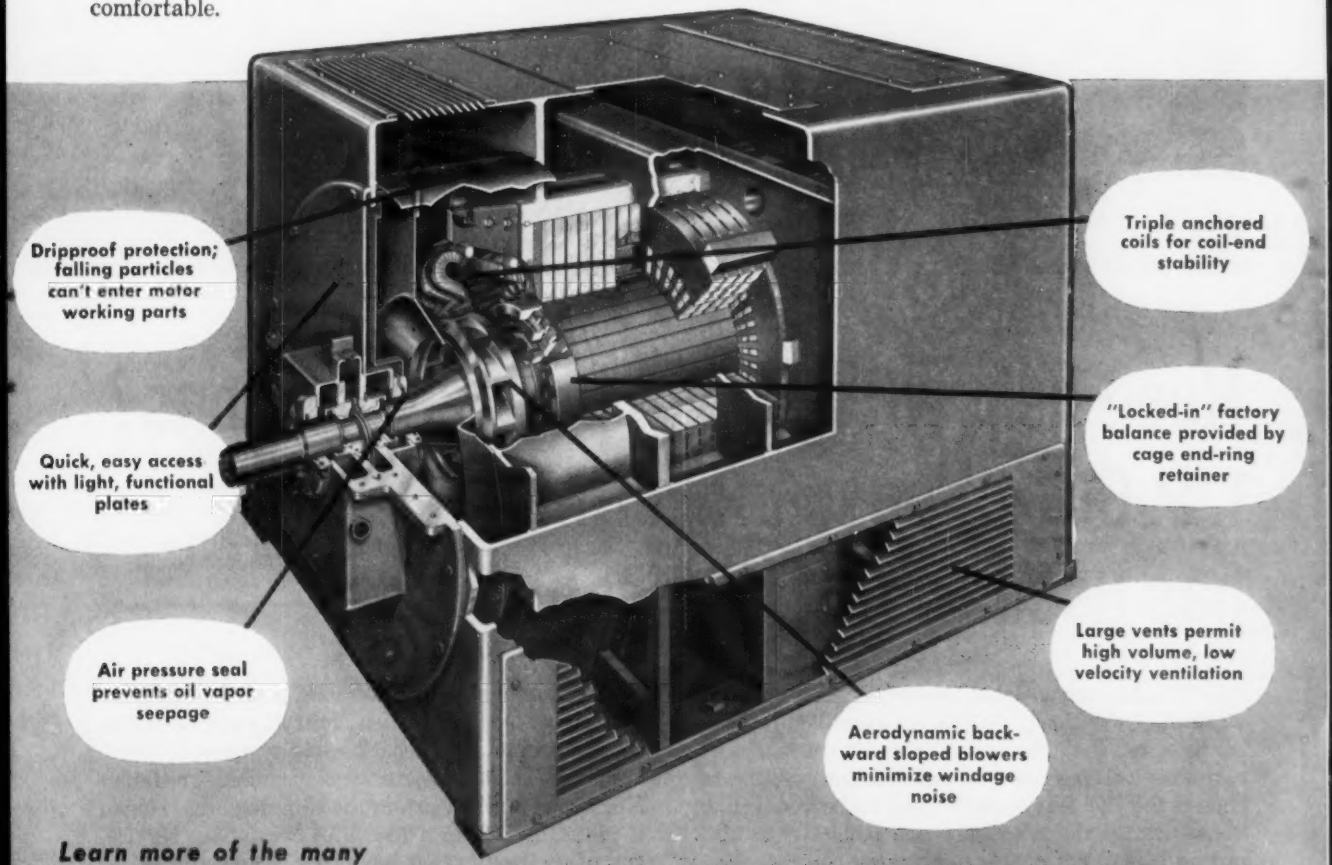
1. NEW TOP DISCHARGE. The new E-M motor ejects ventilating air straight up from the top. The heated discharge air rises straight to the ceiling.

2. COOLER INTAKE AIR. Split-level inlet-outlet prevents cross circulation and recirculation, permits close motor spacing.

3. GREATER OPERATOR COMFORT. No more "face blasting". The new E-M Motor eliminates warm air build-up at operator level, makes work more comfortable.



4. BETTER VIEW OF PUMP ROOM. View-blocking superstructures are gone. The new E-M design is low, modern, compact.


Dripproof protection; falling particles can't enter motor working parts
Quick, easy access with light, functional plates
Air pressure seal prevents oil vapor seepage
Triple anchored coils for coil-end stability
"Locked-in" factory balance provided by cage end-ring retainer
Large vents permit high volume, low velocity ventilation
Aerodynamic backward sloped blowers minimize windage noise

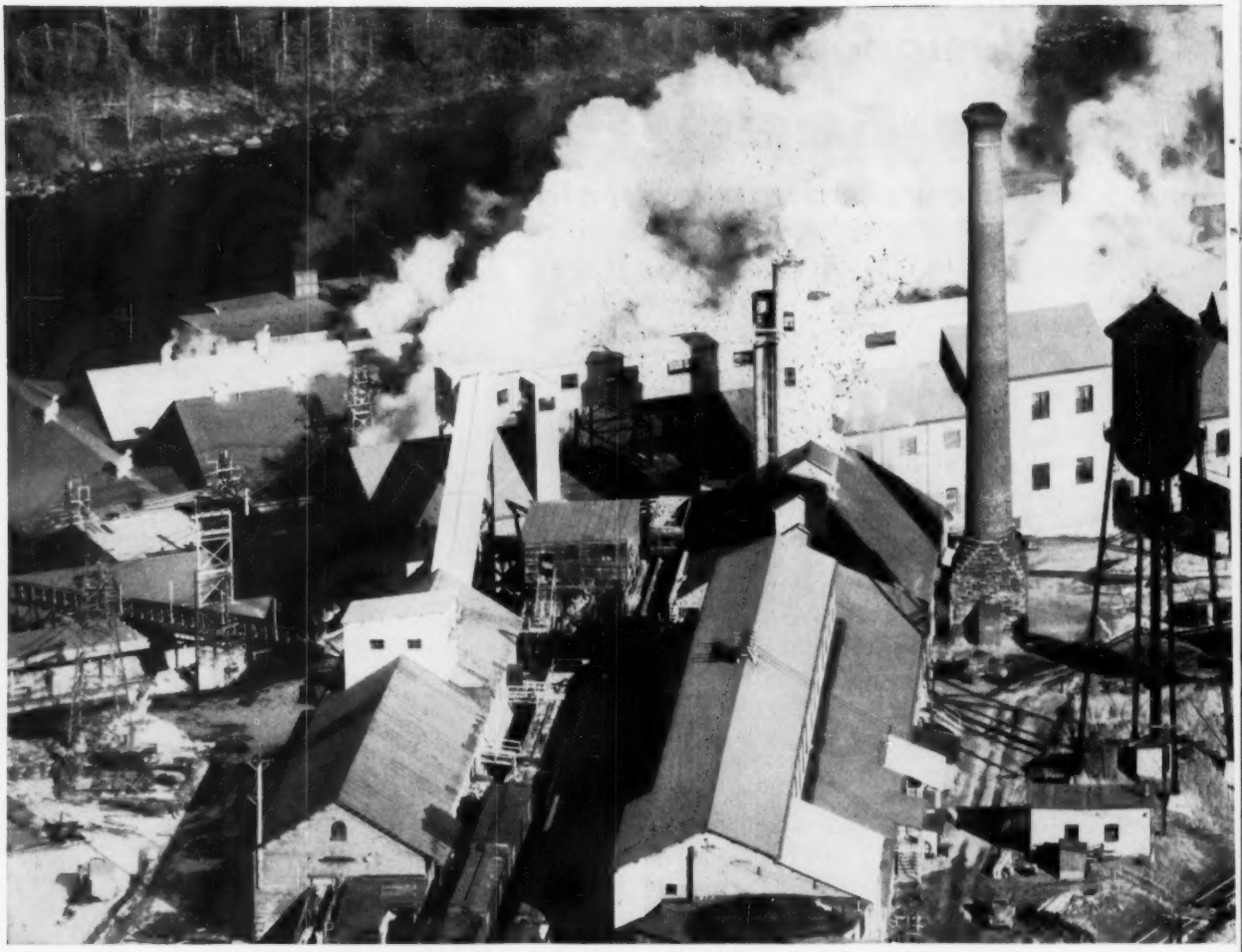
Learn more of the many

BIG DIFFERENCES THAT MAKE THE DIFFERENCE

Find out all about the motor that's "nice to be near." Call your nearby E-M Sales Engineer. Write today for Straight-Up-Ventilated Motor brochure, No. 1134 P.

MFG. COMPANY MINNEAPOLIS 13, MINNESOTA

that performs as well on the job as on the test stand



Aerial view of the International Paper Company plant at Corinth, New York

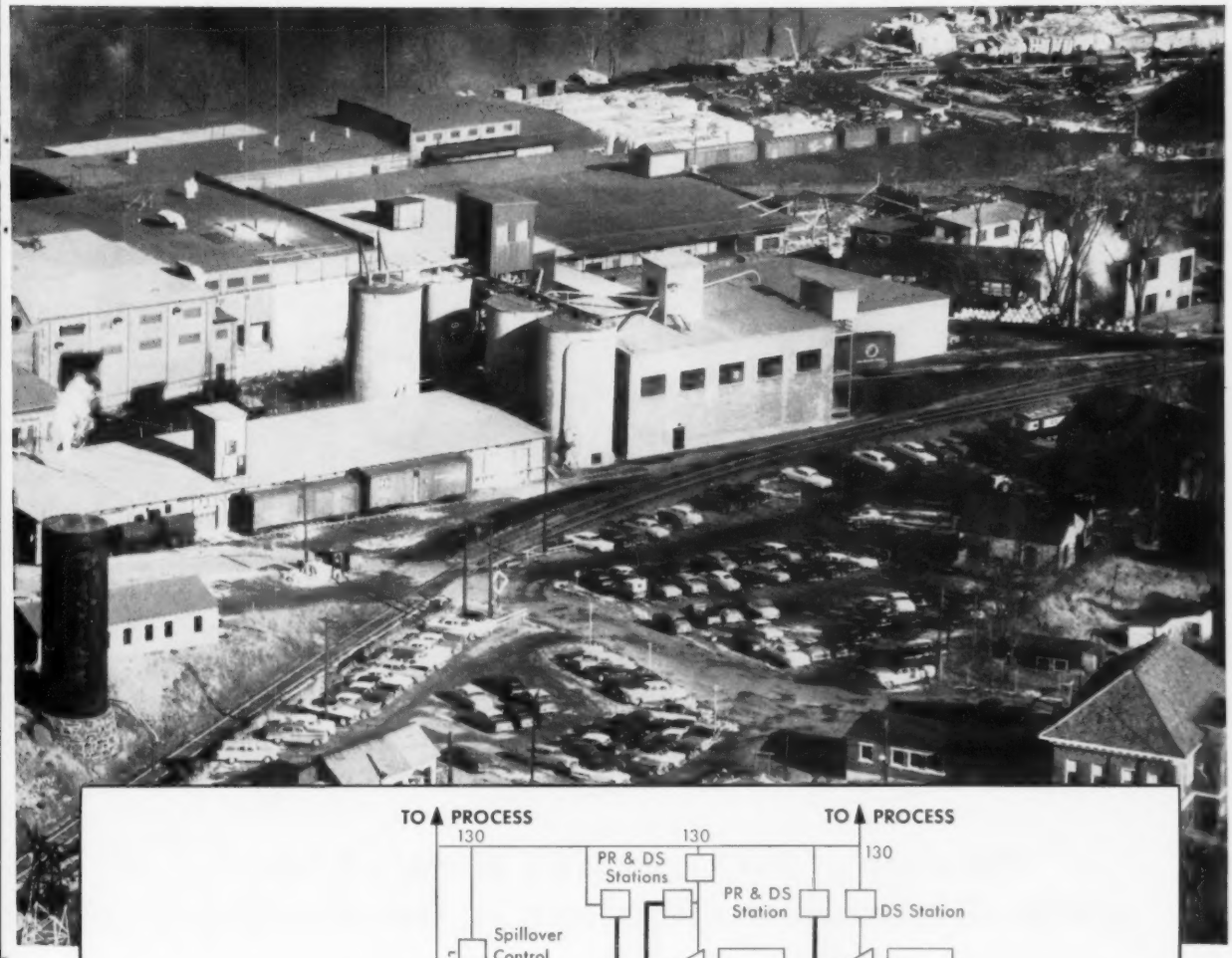
Need help with steam plant expansions? I. P. Co.'s Hudson River Mill has used HAGAN...since 1936

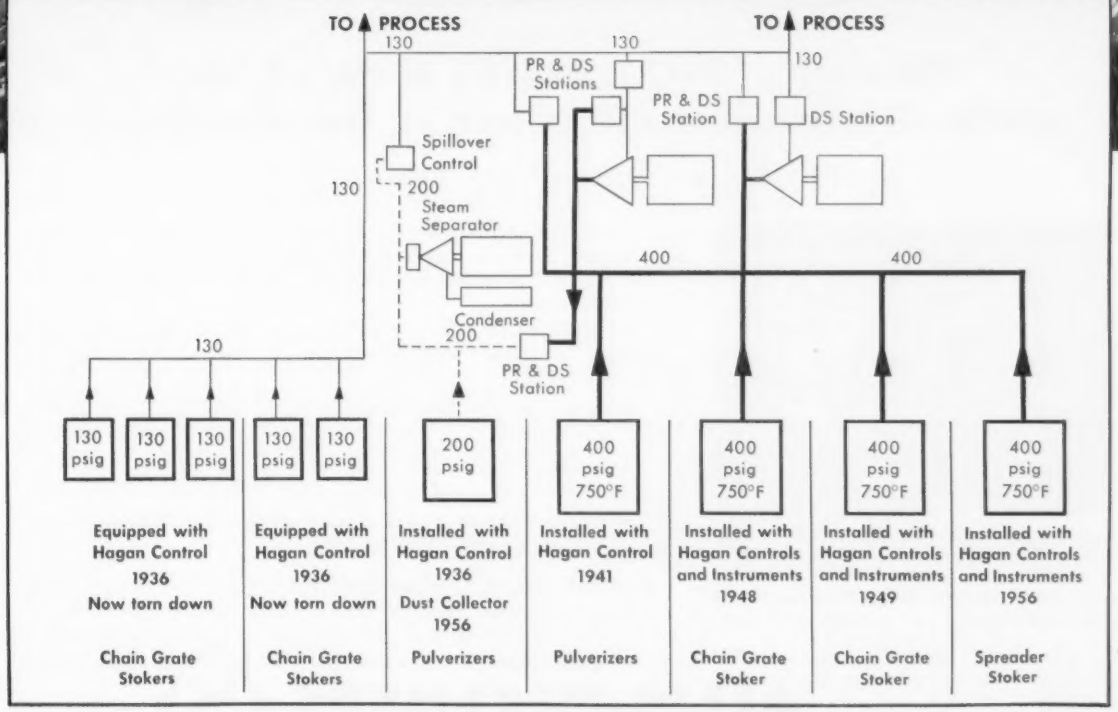
In 1936, the International Paper Company plant at Corinth, New York, decided to install automatic controls on the five boilers then in service (see chronological diagram at right). A Hagan system was chosen for the first three boilers to be converted. Subsequently the remaining two boilers were also put on Hagan automatic combustion control.

Since then, as plant expansions presented new problems of boiler operation and steam distribution, Hagan combustion controls, pressure reducing and desuperheating stations, spillover controls and other systems were added.

Hagan equipment is also used for steam separation, paper machine drying control, water temperature control and chemical feeding systems. In 1956, a Hagan Dust Collector was installed on Boiler No. 7 to control fly ash in the shipping area. Hagan is proud of so long a record of continuous service, and of the results that have been achieved.

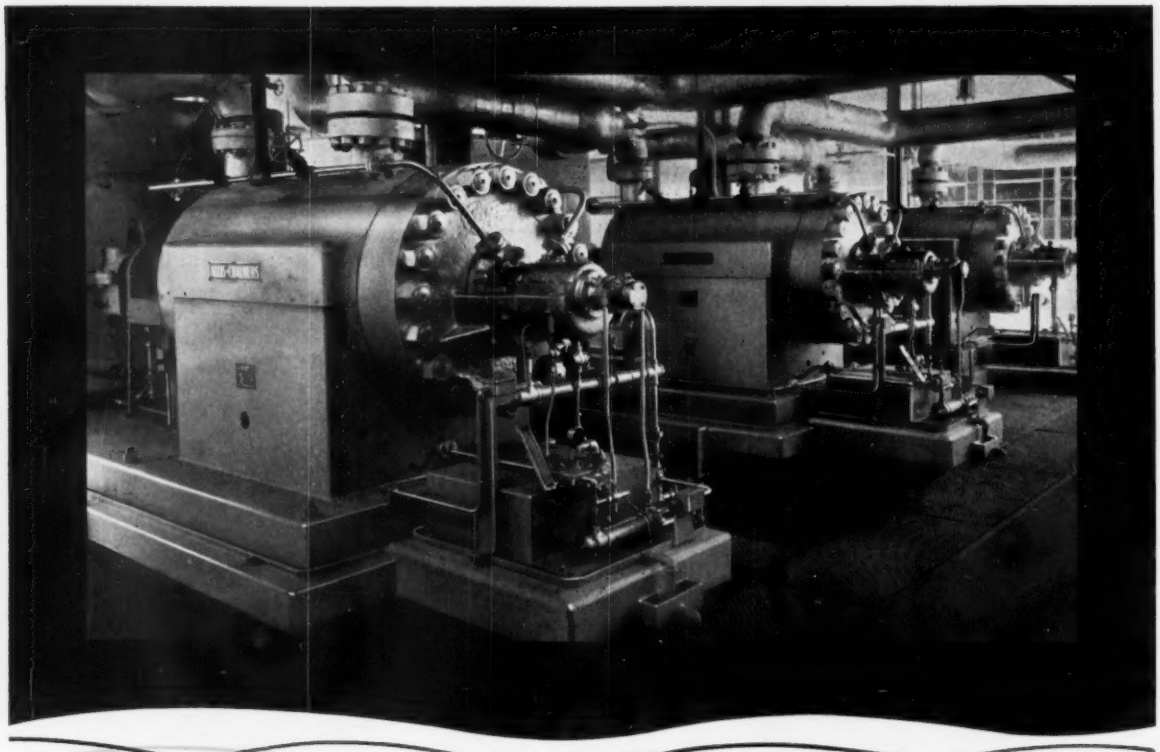
Hagan engineers have more than 37 years of experience in the application of accurate, dependable Hagan equipment to combustion control problems of all kinds. Why not put this experience to work on your control problems.





HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED
OFFICES IN: MONTREAL, TORONTO, VANCOUVER, EDMONTON



There's NO radial thrust in Allis-Chalmers boiler feed pumps

Result: *Smoother running*

SEE HOW Allis-Chalmers boiler feed pumps are constructed. The above model is available for inspection right in your own office. Call your A-C representative or write us.

. . . and this Allis-Chalmers design also pays off in uniform ring and bushing clearances. Balanced thrust also increases the life of close clearances and packing because shaft vibration is eliminated.

In addition to balanced thrust, A-C barrel-type boiler feed pumps are finding ever-greater use in power installations for these reasons:

- First stage has twin single-suction impellers to give low NPSH requirement for highest efficiency under fluctuating loads.
- Expansion joint and shaft seals are brought to outside of pump where they may be easily inspected and maintained.
- You get choice of gland sealing in entire line of pumps from 300-5000 gpm, 1200-4000 psig.

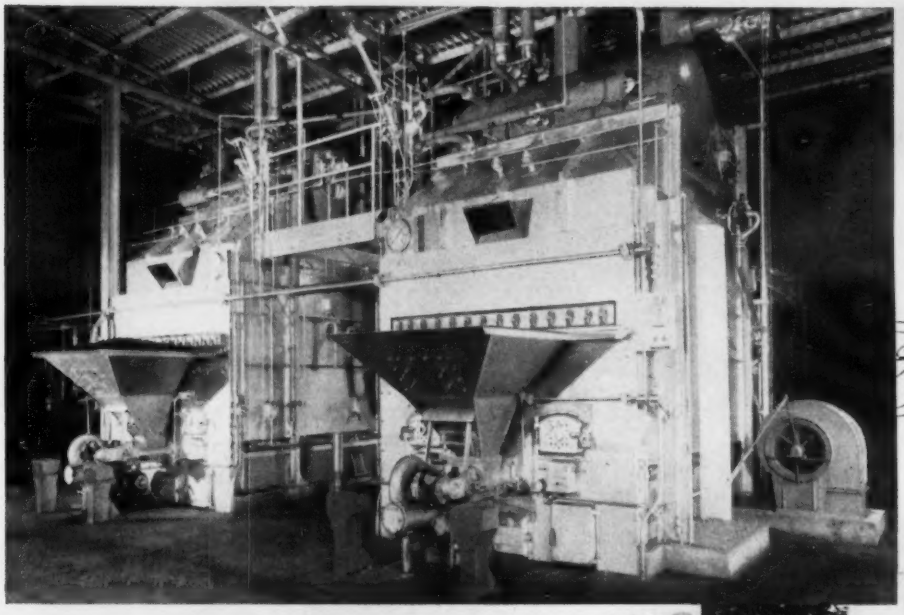
Contact your A-C representative, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5708

DETROIT STOKERS HELP REDUCE COST OF STEAM AT PINEHURST

The Detroit Stoker Equipped Steam Plant at this Famous North Carolina Resort Serves three Hotels, seven other buildings



Steam Plant, Pinehurst, Incorporated, showing Detroit Single Retort Stokers. Boilers are Babcock & Wilcox Integral Furnace Type FF.

John F. Taylor, *Manager Utilities* . . .
Wiley & Wilson, *Consulting Engineers,* Richmond, Va.

The Carolina Hotel, Pinehurst, N. C.— the largest of the three hotels served by this modern plant.

Cost of steam per thousand pounds has been reduced 33.4% by the new stoker — boiler installation, according to Mr. John F. Taylor, Utilities Manager, Pinehurst, Incorporated, Pinehurst, N. C. Amount of steam generated per pound of coal has been increased 22%.

The stokers are Detroit Single Retort Underfeed motor driven . . . the boilers are B&W Integral Furnace Type FF. A master regulator is connected to the Detroit Adjustable Feed Control on each stoker and to the adjustable damper of each motor-driven fan to regulate fuel and air in proportion to the load.

Detroit Underfeed Stokers provide high efficiency at low operating cost with small and medium size boilers.

Write for Bulletins

DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS: MONROE, MICHIGAN

DISTRICT OFFICES OR REPRESENTATIVES IN PRINCIPAL CITIES

DETROIT SINCE 1898 STOKERS

"I cut piping costs with B&W Welding Fittings!"

"Minimum installation time and costs are my responsibility. The dimensional accuracy of B&W Welding Fittings permits quick and positive welding with no erection delays."

Cutting costs is everyone's responsibility. In a piping system, using welding fittings that align accurately is one sure way of saving time and money — in installation and in maintenance. The dimensional accuracy of welding fittings like this B&W Ell assures you of trouble-free fabrication and installation. Their true circularity, full radius, and walls of uniform thickness will enable you to make your piping dollars go farther. Write for bulletin FB504.

B&W Welding Fittings and Forged Steel Flanges are available in carbon steel and the B&W CROLOYS.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION • FITTINGS DEPARTMENT
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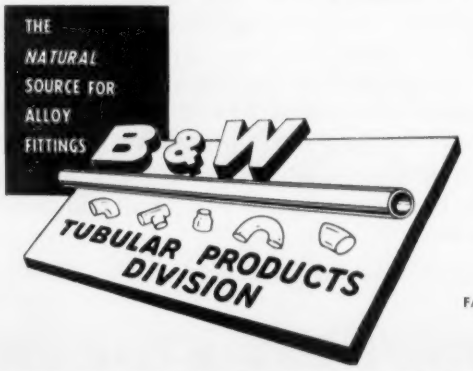

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Seamless welding fittings and forged steel flanges, seamless and welded tubular products, solid extrusions—in carbon, alloy, stainless steels and special metals

LOUIS N ROWLEY, EDITOR • APRIL 1958 • ESTABLISHED 1882 Power

A new look at costs

KEEPING costs under control is part of the working program of every topnotch power-service engineer. But, as in many things we do on a routine basis, a periodic fresh look can be enormously valuable. And it would be hard to find a better time for such a cost checkup than right now, when everyone is cost conscious.

Experts say such a fresh look starts with accurate figures on present expenses. If your normal recordkeeping doesn't yield unit costs in enough detail, it will pay to work them out. For only when you know exactly where you are now, can you develop cost-cutting ideas and measure their effectiveness after you've put them to work.

Next comes a hard look at each cost element. Have any risen disproportionately? Do some run higher than similar cost figures or cost ratios in other plants like your own? And for all cost elements—those that seem to be in line as well as those out of line—what can be done to reduce them, without materially lowering the quality and reliability of the services you deliver to the production departments?

Ask yourself these questions about the fuels, lubricants and maintenance supplies you buy: Are the specifications on the beam? (Maximum economy comes from getting exactly what the job requires, no more and, equally important, no less.) Are you buying in the right quantities and from the most economical source of supply? Finally, are you using these materials to best effect?

Next, you'll want to scrutinize each part of your power-service system. Perhaps a small change in equipment, hookup or operating procedures can yield savings. Or, perhaps deferred maintenance is hampering equipment performance and resulting efficiency gains would outweigh the cost of an overhaul. By all means look sharp for capital improvements—small or large—that will yield long-run savings. Maybe you can't get the appropriation immediately for a major improvement, but the plan will be on tap for the first favorable opportunity.

As a last step, check your manpower situation. Are you using each of your men to best advantage? Could a more effective organization setup make better use of their combined abilities?

With this probing for cost-cutting ideas completed, you're ready to take action.

Two things are worth remembering at this stage: (1) Where top management approval is required, be sure you present your ideas effectively—even a plan for savings needs to be "sold" in the hard-headed "dollar language" top management knows best. (2) Enlist the full co-operation of your staff by taking them into your confidence, telling them why the changes are being made, how they can help make them successful, and what overall benefits will result. Full staff participation is always desirable but is particularly important in a cost-cutting program, which is all too often regarded with resentment and suspicion.

Now, when the climate is favorable, we all have a first-class opportunity to trim any "fat" out of our operations, to streamline them so they will be more competitive immediately and more profitable in the growth years that lie ahead.

"We cut Electrical Installation Costs and got better protection

. . . by installing Fusetron Fuses throughout our New Dairy Plant!"

William J. Oyala
ELECTRICAL SUPERVISOR
Fred Meyer Co. Portland, Oregon

Mr. Oyala continues . . .

"In our new dairy plant in Portland, Fusetron dual-element fuses saved us about $800 by enabling us to use the proper switch sizes for the motor disconnects. This was possible because the long time-lag of Fusetron fuses permitted us to install them in smaller sizes than would have been possible with ordinary fuses.

"In addition, we were able to reduce the space required by the control centers.

"The Fusetron fuses were installed in sizes small enough to give us motor-running protection as well as motor branch circuit protection.

"The result of this has been the prevention of motor burnouts. Not once in the past year of operation has a Fusetron fuse failed to protect a motor. We have 138 motors, ranging from 1/40 H.P. to 100 H.P., and all are protected by Fusetron fuses.

"Both Mr. Eric Christenson, whose company contracted the electrical work, and myself believe that by installing Fusetron fuses throughout our entire plant we got top protection at a cost lower than could have been obtained by any other method."

FUSETRON DUAL-ELEMENT FUSES PROVIDE SAFER, MORE DEPENDABLE PROTECTION

Only Fusetron fuses provide 10 point protection—not possible with any other type of protective device.

Thus, wherever a Fusetron fuse is installed you have safety as sure and dependable as you can buy—no matter what you pay.

AND FUSETRON FUSES REMAIN SAFE THROUGH THE YEARS . . . NO MAINTENANCE COSTS

Once properly installed Fusetron fuses are maintenance free. They require no costly inspection or downtime for calibration and other maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

NO RECALIBRATION COSTS

When a Fusetron dual-element fuse does blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse. The new Fusetron fuse is just as it came from the factory—accurately calibrated—and ready to give the same safe, dependable, coordinated protection as did the one it replaced.

FOR LOADS ABOVE 600 AMPS.—USE BUSS HI-Cap FUSES to coordinate with FUSETRON Fuses.

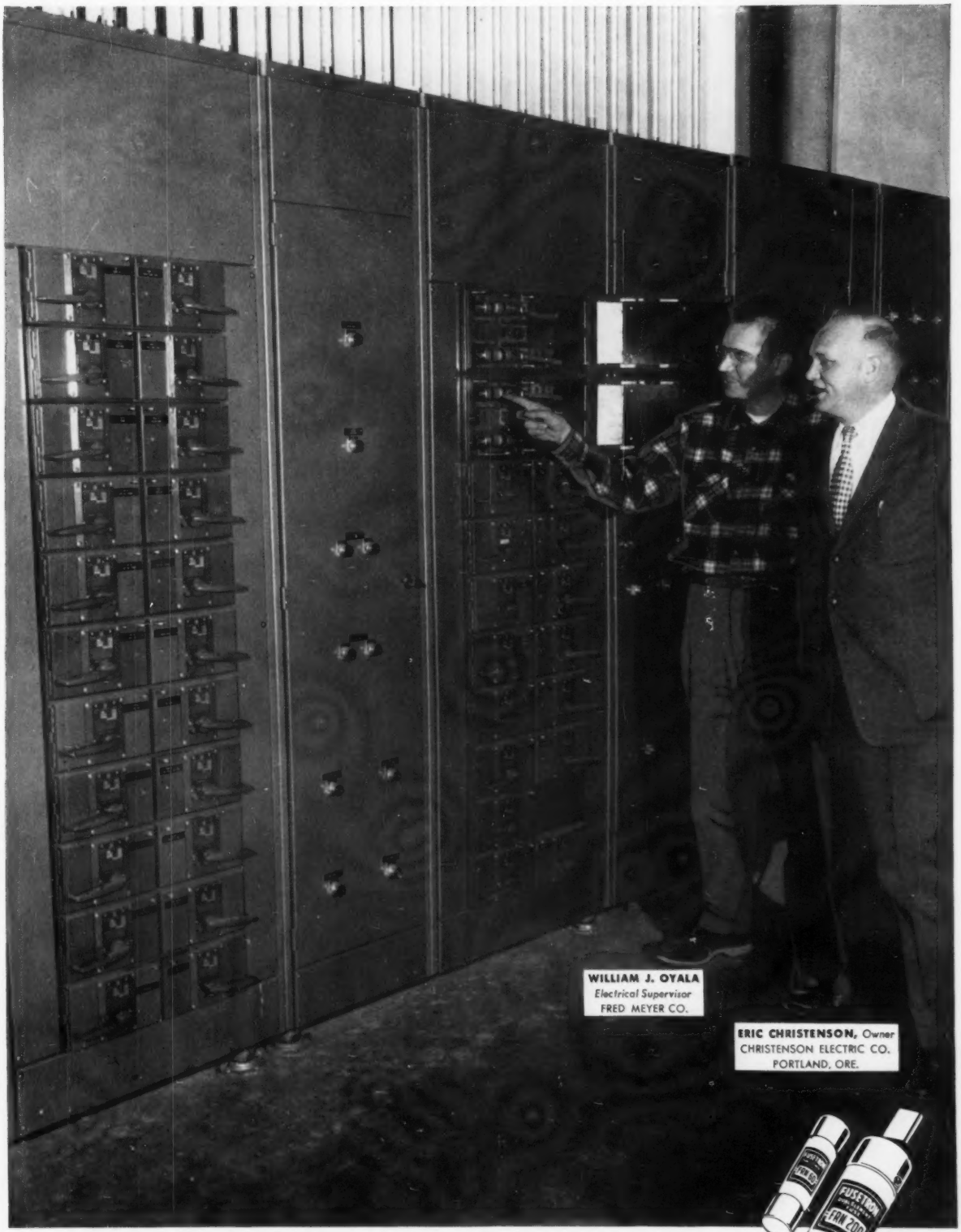
On 600 volts or less, BUSS Hi-Cap fuses have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outage to circuits of origin.

Write for bulletin HCS.

For more information on FUSETRON dual-element Fuses . . . Write for bulletin FIS.

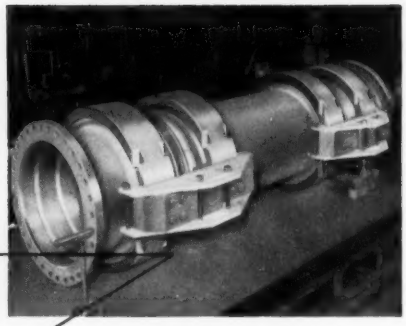
BUSSMANN MFG. DIVISION McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.



Play Safe! Install Fusetron dual-element fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

ALL IN A DAY'S WORK at *Pittsburgh Piping*



Every Pittsburgh Piping job is different, but all are alike in one respect . . . to control the flow and harness the energy of high temperature steam, gases, or liquids at high pressures. It's all in a day's work at Pittsburgh Piping to fabricate piping for a central station, an atomic energy installation, or for industrial and processing operations. Our service includes every phase from blueprint through erection: engineering, metallurgical control, pipe bending, machining, welding, heat treating, inspection, and testing. Use these facilities on your high temperature, high pressure piping jobs.

this BIG 10-TON EXPANSION JOINT

36" carbon steel joint, weighing ten tons, for cross-over piping in central station.

and this small PRESSURE RISER CONDENSER

Pressure riser condenser, fabricated of Stainless Steel Type 347; 2 feet high; wall thickness equivalent to 4" Schedule 160S. Stainless steel pressure vessel, for atomic energy application, appears in background.

Promoting Progress **IN POWER AND PROCESS PIPING**

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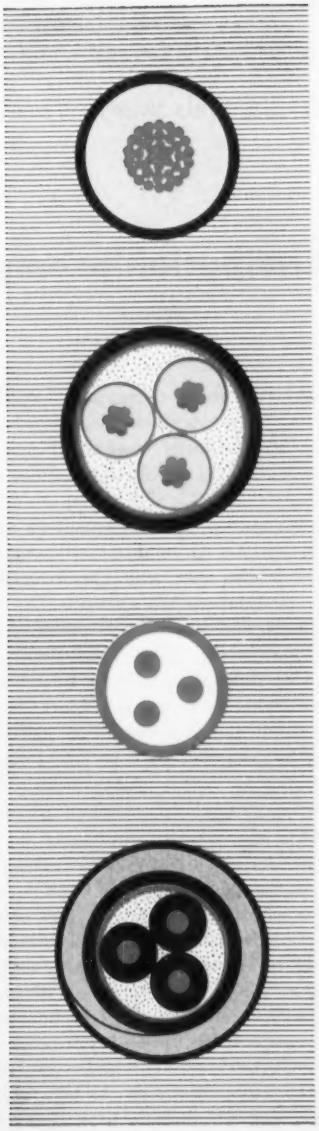
B G A SKROTZKI
Associate Editor in Charge

a Today's Development report

With industrial loads burgeoning, cable makers are digging deep into their research and development pockets to meet demands for even better . . .

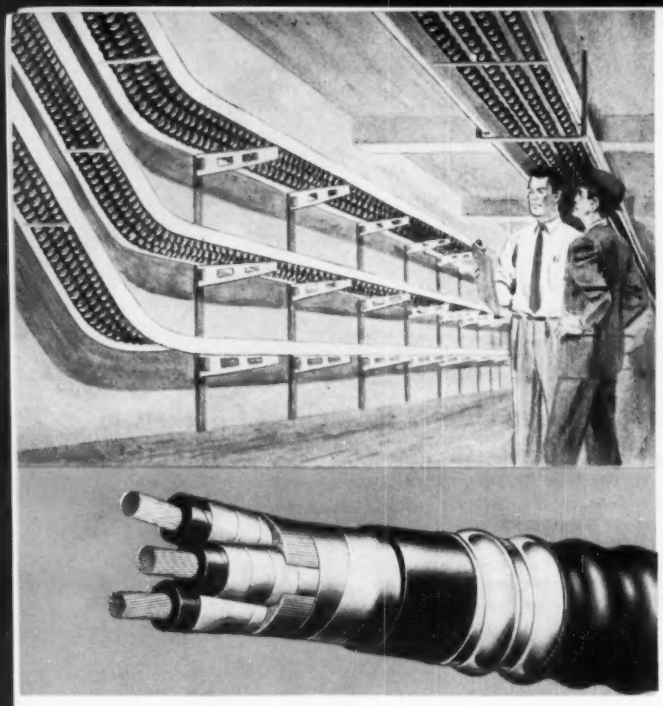
Insulated power cables



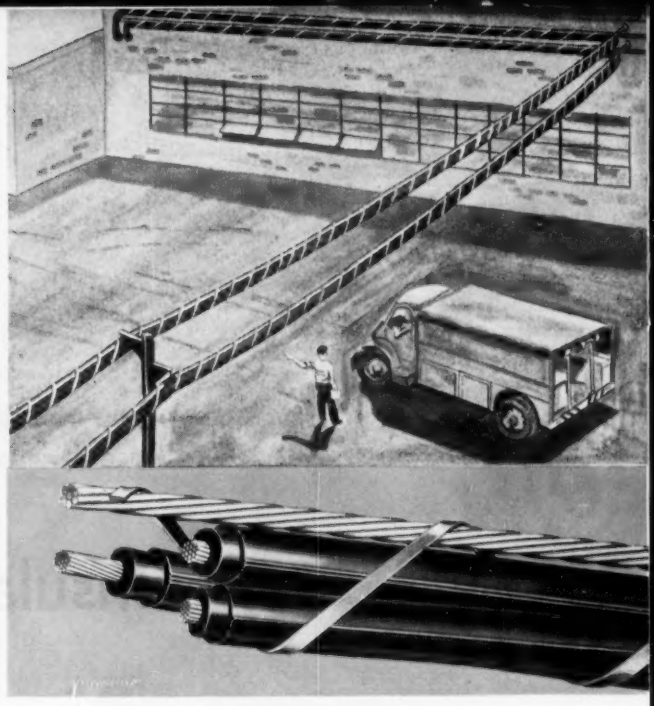
- Polyethylene is leading contender in scramble to come up with an all-purpose insulation. Cable makers are trying hard to design-in needed characteristics
- As voltages climb, corona takes on greater import for many jobs. So right now big question is "When is cable shielding needed?" Experts differ in opinions
- Easier installation keeps pressure on cable designers. Interlocked armor and insulated aerial cable find wider use, are adapting to corrosive atmospheres
- Standardization of insulations is sought. It won't be easy problem to solve; new kinds keep coming along faster than old ones drop out

By NORMAN PEACH, Assistant Editor

Insulated power cable is being called upon to distribute the bulk of power in industrial plants, commercial buildings and power plants. Developments in cable design and application are coming along fast to solve problems of distribution under today's exacting conditions. In these areas, both primary and secondary distribution are at generally higher voltages—69 kv for primary distribution in some plants. This *Today's Developments* report brings you up to date on where and how cable is used today, and what you can expect of insulations, conductors, protective jackets and armor, terminations and methods of installation. There's a glimpse into the future, too.



ARMORED CABLE handles concentrated loads



AERIAL CABLE finds many new uses

Exacting demands of today's power distribution prompt

Plans for electrical distribution are specifying some method other than cable in conduit to an ever-increasing extent. This holds for both primary and secondary distribution. Advantages engineers seek are (1) less installation work, reflected in lower costs and faster completion of the job (2) more flexibility in regard to changes in the system (3) expansibility—Power to Grow . . . *electrically*. Often lower first cost is a factor, too.

Distribution methods

Armored cable, its versatility increased by improvements in armor, jackets, terminations and supporting hardware, is being used in varied applications. Included are many tough jobs met in the chemical industry. New continuous-metal armor, impervious to gases and liquids, p 76, promises to fill in some of gaps where interlocked armored cable isn't suitable. Armored cable provides conductors, insulation and protection against mechanical and chemical damage all in one piece. Improved pulling equipment includes a variety of pulleys and rollers to make the job easy.

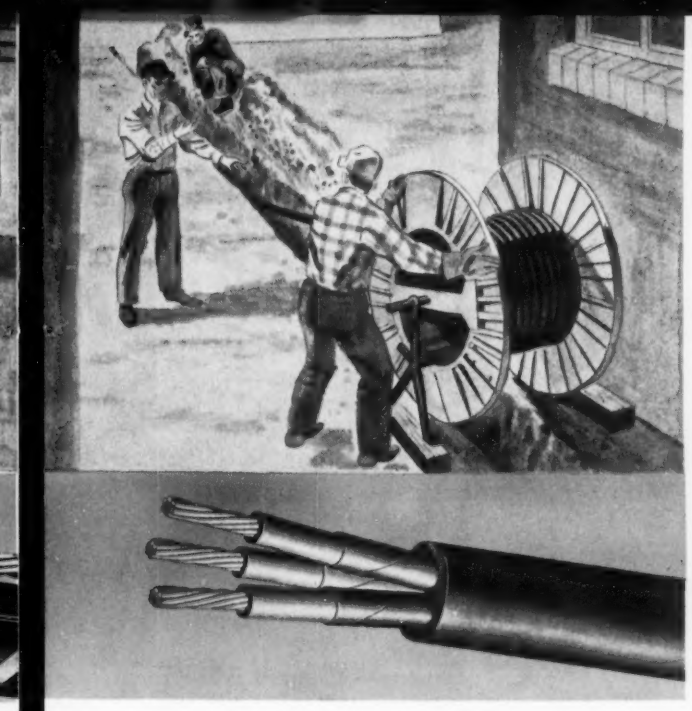
Armored cable can be supported in a number of ways to fit particular conditions. Favorite interior method is on ladders. Manufacturers' catalogs of ladder sections and fittings are getting fatter yearly; assembly techniques are simplified. Outdoors, armored cable is slung from messenger, lashed to poles, carried by wall brackets, supported by bridges or run through concrete troughs. Transition from indoors to outdoors is simply through a hole in wall; no special termination is required. Speaking of terminations, big boost for armored cables comes from simplicity of compact, mechanically assembled splices which don't require special skills needed to make lead-cable splices.

Aerial cable, mostly preassembled type, will be seen in more industrial plants. It's an outdoor cable, good for long spans. Hazard is less than with bare overhead cables; clearances can be smaller. It's cheaper than installing underground ducts, and rerouting is easier. Corona problems can be less severe. These considerations may offset risk of storm damage, snagging by cranes, etc. More engineers are trying aerial cable indoors.

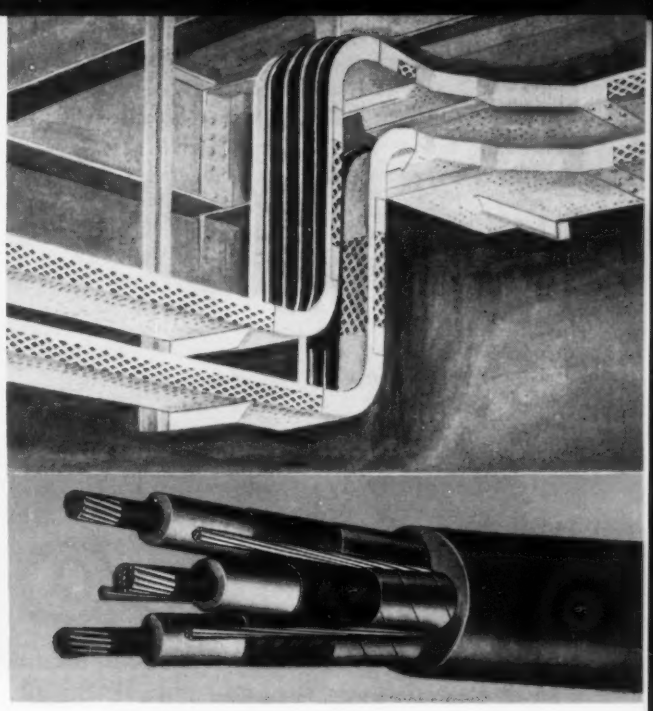
Direct burial is a not too common, but growing method of distribution in industrial plants. Trend stems from increased confidence in jackets and armor, p 78. It's often less work to dig up cable, if necessary, than to pull new cable into ducts.

Conduit is not on its last legs by any means. It's still getting a large share of new construction. Behavior of cable in conduit is known from experience, and many engineers claim that for severe operating conditions it can't be beaten. Cable for use in conduit is generally less expensive than other types. Manufacturers of plastic-jacketed conduit, p 79, are doing a good business.

Mineral-insulated cable (NEC Type MI) shows no signs of competing with the more conventionally insulated cables in areas where latter can handle the job. In applications of extreme temperature, especially high heat with



DIRECT BURIAL is used between buildings



TROUGH carries variety of power cables

new cable application techniques

moisture where organic insulation is likely to be "cooked," MI cable is coming into its own. There are advocates of more general usage who recommend it for its space saving and its impervious, rugged armor. Terminations aren't difficult, but must be made moisturetight because mineral insulation is very hygroscopic. There's no prospect of raising voltage above 600 volts. Aluminum-sheathed silicone-rubber cable offers competition.

Voltage and temperature

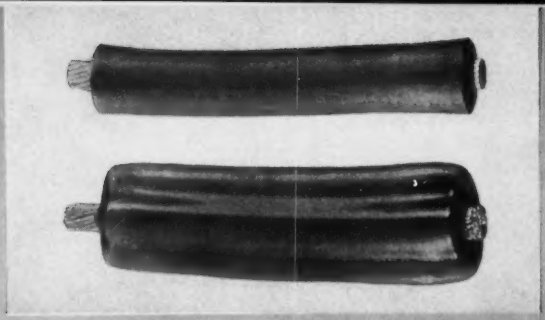
Most obvious change in electrical distribution in last decade is the trend to higher voltages. Higher voltages in the plant offer a challenge to cable manufacturers to produce cable which will operate trouble-free under the more exacting conditions of higher insulation stresses. But, at the same time, this cable must not be disproportionally higher in price, or involve much more complicated installation methods. Dielectric breakdown of intact insulation is not big problem with today's materials.

Corona becomes a factor to be reckoned with when cables are operated at higher than about 3 kv. Best answer to the corona question is use of shielded cable. But, shielding is expensive, both from cable-cost standpoint and labor involved in installation. A hard-and-fast rule to determine when shielding is necessary can't be found; it's a matter of controversy among cable manufacturers. There's not much dispute that shielding can usually be omitted below 3 kv and that it can't be safely omitted at 15 kv. In-between voltages, for practical purposes 4160 volts, is the range where opinions differ.

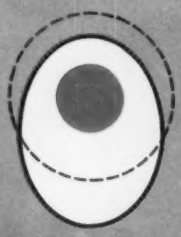
Toughest corona conditions are met where single-conductor, rubber- or thermoplastic-insulated cables are run in conduit with uneven conditions of moisture—part of cable dry, part wet, part caked with clay, etc. It's not an easy matter to predict what the conditions in a duct will be like throughout the cable's expected life. Lead cable, armored cable and aerial cable can be unshielded at higher voltages because construction itself provides a certain amount of shielding.

While most manufacturers recommend sticking to 3 kv maximum for unshielded cable in conduit, as specified by ASTM and IPCEA (Insulated Power Cable Engineers Association), others believe this is too conservative. They contend, in all but most severe conditions, that today's improved cable design makes shielding unnecessary for 5 kv, so why not take advantage of it? It is likely to be some time before unshielded cable is corona-proof at 5 kv; however, considerable economies can often be effected where experience and confidence in supplier indicates use of unshielded cable. Some manufacturers advocate a polyvinyl-chloride or neoprene jacket to minimize corona damage.

Cable temperature, apart from ambients, depends on tolerable conductor losses as well as insulation. There's a trend toward working conductors harder; many plants need extra power from existing systems. But, there's an economic cutoff point. Studies indicate 85 C is about tops for temperature originating in load on the cable.

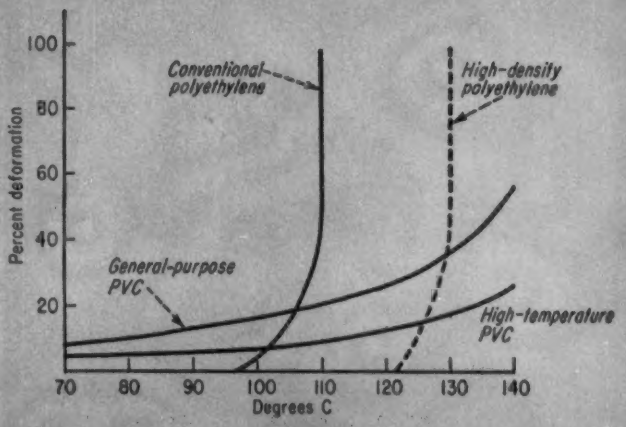


IRRADIATED polyethylene, *top*, didn't deform after two hours in air oven at 160 C. Note flowing of nonirradiated polyethylene



ECCENTRICITY due to cold flow can cause dangerous reduction of insulation wall

Temperature and the new polyethylenes



DEFORMATION of thermoplastic insulation on wire with respect to temperature. Note stability of polyethylenes up to definite limit

Insulation, key to cable performance, offers big challenge

How much standardization?

Many engineers who work with cable—consultants, manufacturers and plant people—wish it were possible to standardize on a few insulation types. Some even suggest six basic types—each representing one of today's broad classes—are enough: (1) polyethylene (2) polyvinyl chloride (3) butyl (4) neoprene (5) varnished cambric (6) paper-oil. This doesn't exclude noncompeting specials like silicon rubber or MI. Today, NEC lists many types and every manufacturer has a variety of compounds to offer.

Difficulty arises because research constantly turns up promising new compounds. These are promptly put into production to keep ahead of competition, to pay off research costs, or to gain essential field-test information. New types appear faster than the old types drop out of use. Specifications by standardizing bodies such as IPCEA and ASTM, necessarily take considerable time.

Desirable as standardization may be, it mustn't be stultification. Some engineers claim that multiplicity of types is the only way to find better compounds. All agree it will take some years before the number of insulation types on the market is reduced.

The ideal all-purpose power-distribution cable insulation would have to have a number of outstanding properties. Among these are (1) adequate dielectric strength through the entire distribution-voltage range with reasonable wall thickness (2) ability to withstand corona in voltage range where shielding is not necessary for other reasons, such as shock protection (3) property to endure temperatures from about 200 to −100 C indefinitely (4) flexibility throughout entire temperature range (5) toughness (6) good impulse strength—electrical, mechanical, thermal (7) chemical and physical stability—that is, it must age well and not decentralize (8) resistance to deterioration by moisture, chemicals, oil, ozone, sunlight, flame (9) adaptability for extrusion as well as wrapping, and (10) it must not be excessively expensive.

Today's developments are aimed toward ideal insulation, but have a long way to go. However, properties of many materials are steadily improving.

Polyethylene

There are four branches to the polyethylene family: conventional, high-density, irradiated and chemically cross-linked. All but conventional are still experimental and can't be classed as today's insulations, though they're sure to be in the picture tomorrow.

Conventional polyethylene, so-called to distinguish it from more recently developed forms, has given a good account of itself in the 5- to 15-kv range for several years, and 34-kv cables have been successful. It has high dielectric strength (500 volts per mil) and good thermal conductivity; wall thickness can be 30% less than com-

parable rubber cables. Corona discharge resistance, on the other hand, isn't good and precautions must be taken to prevent formation of voids.

Conventional polyethylene softens at 110 C and upon cooling may have decentralized or included voids, leading to corona trouble. Beyond 110 C it melts. Below 100 C its physical characteristics are practically constant, even at subzero temperatures, see chart page 76. It has a high coefficient of expansion. Unless carefully made, temperature cycling could result in voids.

Compared with rubber type compounds, polyethylene is stiff and its wall thickness is limited. It's fairly abrasion resistant, with smooth, waxy surface which aids pulling. Its resistance to most commonly encountered chemicals is good and ozone resistance is excellent. It has lowest moisture absorption of any commonly extruded cable insulation. This property is particularly significant for dc distribution since tendency to absorb is greater than with ac. Polyethylene burns readily. Aging properties are good; heat aging is said to improve physical characteristics. It can be extruded or wrapped as tape.

Economically, conventional polyethylene has much to recommend it. In the 5-kv range, it's today's lowest cost insulation for unshielded, nonmetallic-sheathed cable. A 5-kv shielded polyethylene cable costs less than a 5-kv unshielded rubber-insulated cable.

High-density polyethylene has advantages over the conventional variety. Its softening point is appreciably higher, 135 C, which is in the range of destructive temperatures of many other insulations including paper-oil. Resistance to abrasion is improved, but stiffness is increased in compounds developed so far. The approach that results in temperature improvement also promises to improve corona resistance.

Irradiated polyethylene takes on thermosetting properties. Melting doesn't occur until destructive temperature is reached. Physical characteristics are improved, including flexibility, as are chemical and corona resistance. Polyethylene's good electrical properties are not affected by irradiation. Cost is high and seems likely to remain so. At present, irradiated polyethylene is used mostly as tape rather than extruded, since film is less expensive to irradiate.

Chemically cross-linked polyethylene is new; many problems have to be licked before it's established in the insulation field. Mechanical properties compare favorably with irradiated form, but to date electrical properties are poor, excluding it from the h-v domain. Ultimate cost promises to be much less than irradiated compounds. Several chemical companies are developing it. With fillers it is being tried in the l-v range; these compounds can take 250 to 300 C, experimenters claim.

Rubber

Rubber is a handy name applied to numerous elastomeric compounds besides natural rubber. The latter plays a small part in power-cable insulation, while synthetic types account for the bulk of cable insulations. Among these are some which show continued development.

Butyl rubber has best resistance to heat, moisture and ozone of all common rubber type compounds. Its use is growing in the 600-v to 5-kv range. Developments such as bromination, curing accelerators and fillers for better mechanical properties are under way.

Silicone rubbers have promising characteristics; they're far more heat resistant than butyl and appear to be completely impervious to ozone and corona. Some can operate at 200 C continuously, and remain flexible at –85 C. Aging is excellent. Drawbacks are lack of mechanical toughness, susceptibility to attack by certain chemicals and high price. However, recently developed silicone rubbers are claimed to have tensile strength of 2000 psi and better chemical resistance. Interest today is mainly for high-temperature applications, but further development of these compounds may produce wider use.

Hypalon, a chlorosulfanated derivative of polyethylene, is still in the development stage for insulated cables. It fits into the low- and intermediate-voltage range, resembles neoprene, but is better in most physical and chemical properties except oil resistance. Electrical losses are excessive at high voltages. It appears to be impervious to ozone and corona attack.

Polyvinyl chlorides

Prominent in the field below 600 volts, pvc has made a moderate bid for cables up to 5 kv. It's an outgrowth of recent developments of semirigid compounds and high-temperature plasticizers. Approval of 75 C for general insulation is in the wind; it's already in use where Code doesn't apply. Silicone films can serve as pulling lubricant.

On the horizon

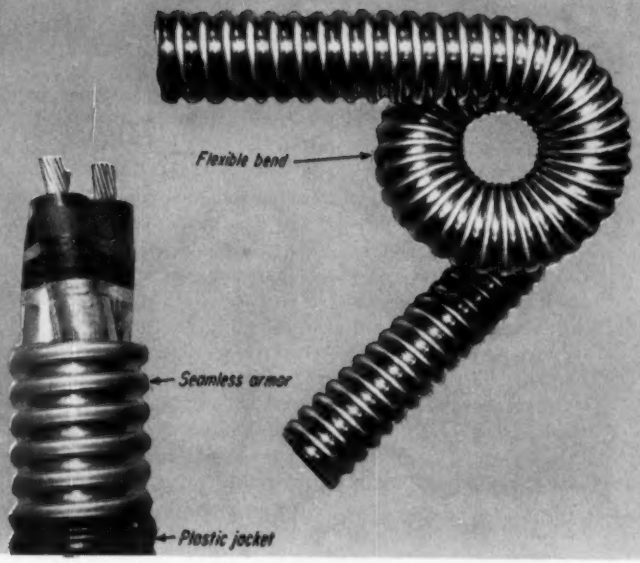
Some compounds with properties interesting from point of view of cable insulation are in the experimental stage. Polypropylene is one, reported at least as good electrically as polyethylene and greatly superior in mechanical and chemical properties. Synthetic papers have been mentioned which might effect changes in that most conservative of cables, the oil-filled-paper type. Teflon, with outstanding temperature characteristics, is getting closer scrutiny. Nylon, mylar or other films may find a niche in insulation of future cables.

A quick look at leading insulations

	Maximum temp, C	Voltage range	Advantages	Disadvantages
Polyethylene Conventional	75	to 15 kv	Electrical properties Moisture resistance Low cost	Low melting point
High-density	above 100	—	Toughness, durability	Stiffness
Irradiated	above 100	to 5 kv	Thermosetting properties	High cost
Chemically cross-linked	above 100	to 600 v	Heat resistance	Lowered electrical properties
Butyl	90	to 35 kv	Temp rating	Low oil resistance
Pvc	105	to 600 v	Inertness, low cost	Dielectric losses
Silicone rubber	200	5 kv extruded 24 kv taped	High temperature Moisture resistance	High cost

Fluid-tight metal armor bows in

Corrugated metallic sheath has been in use for a decade in Europe, is now made in the United States. A strip of steel is formed around the cable and the seam is welded automatically. Sheath is then corrugated on the cable. The sheath, or armor, is gas- and liquid-tight against both internal and external pressure. It's flexible and has good fatigue strength; bending is limited only by the cable inside. Protection against blows or crushing is better than lead, but not up to interlocked armor. Aluminum has been used, but it isn't comparable to steel yet. Corrugated metallic cable has a good record for direct burial in European installations.



Protection of cable from environment, simplified

Generally, cables are protected with sheaths of lead, aluminum, rubber or plastic. Their twofold purpose is to exclude fluids and provide some mechanical protection. On oil-insulated cable the lead sheath retains oil. Strictly speaking, sheaths or jackets don't provide electrical insulation, but usually nonmetallic sheaths are made of related materials. Some engineers feel the development of nonmetallic sheaths has lagged insulation's growth.

Sheaths

Nonmetallic sheaths or jackets are commonly made of neoprene, polyvinyl chloride, natural rubber, buna-S rubber or polyethylene. Chemical resistance is often important. Nonmetallic sheaths are placed over lead sheath and interlocked armor for particularly corrosive atmospheres or soil conditions.

Polyethylene is a widely used jacket because of its good resistance to chemical attack and abrasion, especially as protection against electrolytic currents on buried metallic sheaths. Its acceptance as a substitute for metallic sheath is increasing. A jacket compound incorporating high molecular weight polyethylene and a small percentage of well-dispersed carbon black for weather and sunlight resistance would fill the bill for most applications.

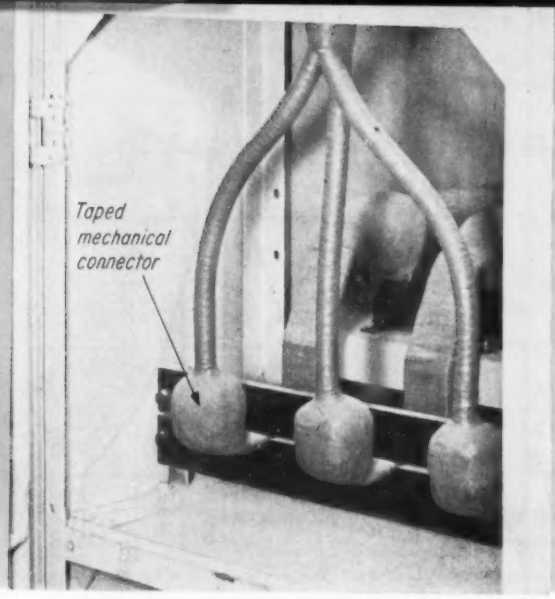
Polyvinyl chloride has established a reputation as cable sheath, and its possibilities are not yet exhausted. These compounds are chemically resistant to practically all corrosive conditions to which a cable may be exposed. Polyvinyl-chloride jackets are often used on polyethylene-insulated cables. Pvc can be supplied in vivid colors to provide circuit identification. However, it has low-temperature limitations; jackets stiffen below 0 C and generally shatter on sharp impact in the –10 to –30 C range.

Neoprene, an early nonmetallic sheath, is today's standard sheath for portable cables. It's tough, has good resistance to weathering, oil, ozone, flame and soil bacteria. It's popular for protecting lead against electrolytic attack in spite of rather high moisture absorption. This defect has recently been reduced by special compounding.

Hypalon shows promise as a jacket for very adverse operating conditions of h-v cable; its properties are described on p 77. Nylon is used as a thin tough jacket for severe abrasion conditions, but has found few applications in power distribution due to poor moisture resistance.

Metallic sheaths offer less variety of properties. Lead alloys are being improved to get more toughness, better fatigue strength and easier extrusion, but results can't ever be spectacular. There's considerable interest in aluminum sheath for non-oil-filled cables. It's much tougher and lighter and is attractive for suspended applications. Fatigue strength doesn't measure up to lead as yet. Manufacturing methods are in the development stage. At present, sheath is swaged on cable, but extrustion is successful in Europe and is just around the corner in the United States.

Armor, as distinguished from sheath or jacket, is intended primarily for mechanical protection. Interlocked armored cable is likely to have nonmetallic sheath under the armor and may have another over it. Steel, aluminum and bronze each have their place as interlocking armor, and methods of manufacture are giving improved strength, flexibility and lighter weight. Sheathed conduit, a galvanized conduit with a thermoplastic coating, such as a vinyl compound, is conduit's answer to the growing concern about corrosion. Connections are covered with tape. With installation costs high, some industries which



Simplified terminations for h-v

Potheads and lead wipes are slow, require skilled installers. Cable designs, such as polyethylene, that can be successfully terminated with taped splices are growing in popularity through 15 kv. Techniques are well developed, including work-saving tools and filler compounds to eliminate formation of voids. Pressure type connectors are available for use with nearly all power cable. Stress cones are readily made at terminations by building up tape and covering with shielding tinsel braid. Rain shields can be included for outdoor terminations. Outdoors, most engineers still favor porcelain potheads for permanent 15-kv terminations.

installation spur new developments

had a rapid replacement rate are looking for ways to extend life of power feeders. There's been some talk of plastic conduit, but to our knowledge no manufacturer is developing it as yet.

Conductors

When you talk about conductors, you're talking economics rather than engineering. There's no suggestion of new conductor alloys revolutionizing the conductivity of cables, so choice remains between copper and aluminum. This choice is likely to be determined by contemporary differential in market price. There are few engineering difficulties left in using aluminum. Most consultants recommend it without hesitation where its lighter weight has advantage over its greater bulk. (Let's say for aerial cable as against pulling into conduit.) But it requires more skill on part of electricians; not much more, but enough to discourage some contractors. A careless workman has more of a chance of "seeding" troubles which will develop when system is operating. Aluminum people are working hard to get simpler connectors.

Protection in service

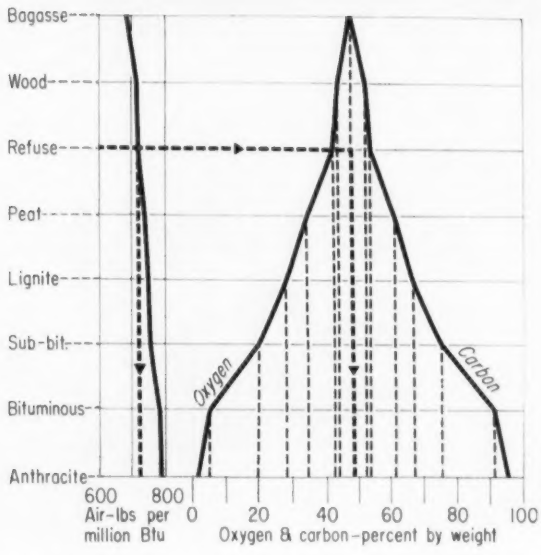
Manufacturers do their best to make cable rugged enough electrically, mechanically and chemically to stand up under most adverse conditions. However, best performance of power cables depends on proper application and protection. We've already talked about shielding from point of view of corona damage, p 75. Also to be considered under some conditions is its value in preventing shock from charge on outside of cable and for limitation of charging currents due to system transients. Hazards of lightning surges are more widely recognized and methods for better protection are being devised. Complex effects of soil conditions on underground cables are in process of investigation. It is safe to say that need for sound engineering of power-cable installation is better understood than ever before.

Nondestructive testing eliminates weak links

Power cable, like the proverbial chain, is no stronger than its weakest section. More and more cable manufacturers are devising tests which subject every inch of cable to scrutiny. Most significant of these tests is corona level indication, which can be conducted on a full reel of cable or on a section of cable at a time as cable is fed continuously through test setup. Such tests can locate flaws, such as decentralization, voids, contaminant inclusions. X-ray tests provide internal inspection and reveal such serious defects as broken or damaged conductor strands, improperly applied shielding tape, etc. So far, nondestructive testing is used only to increase reliability; manufacturers don't anticipate any reduction in safety factors, such as wall thickness, as result of better quality control. Impulse strength is a major factor in determining what thickness of cable's insulation wall should be.

By H G MEISSNER
Combustion Engineering, Inc

For today's industrial plant engineers faced with increasingly heavy refuse disposal problems, here's a discussion that highlights all the basic factors involved in . . .



1 **FAMILY TREE** shows how refuse fits into combustible material category. Chemistry stays uniform despite random makeup

Designing a modern incinerator

Refuse removal is no longer a headache for the municipal engineer alone. Today's industrial plants face similar increasingly heavy waste disposal problems. Result: The traditional incinerator is going by the boards; it's being replaced by designs using modern engineering know-how.

Let's take a look at existing incinerators. Practically all have a common serious fault: they must be batch-fed through doors either in front or on top of the furnace. This either stuffs or starves the fuel bed, with excess air in inverse ratio. Too, the units have to be manually cleaned, often at short intervals, again with much uncontrolled air leakage. Resultant highly variable fuel-air ratios and furnace temperatures are reminiscent of hand-fired coal-burning boiler days.

As refuse falls through the rising gas stream much of the lighter material entrains and flies from the primary chamber unburned. It's *supposed* to burn and settle as ash in the secondary or combustion chamber. But, tests show that (1) little combustion occurs in the secondary chamber (2) if the primary chamber had added combustion space, the secondary chamber could be omitted.

Example: Common value for combined furnace and combustion volume has been 25 cu ft per ton of rated capacity. This means a conservative 16,700 Btu per cu ft per hr when using 417,000 Btu per hr. (Latter is value for heat released in burning refuse at the rate of a ton per day.) However, only 10 cu ft of this is allocated to the primary furnace. This means that the primary furnace's heat release is 417,000/10, or 41,700 Btu per cu ft per hr which is more than double the recommended rate of 20,000 Btu.

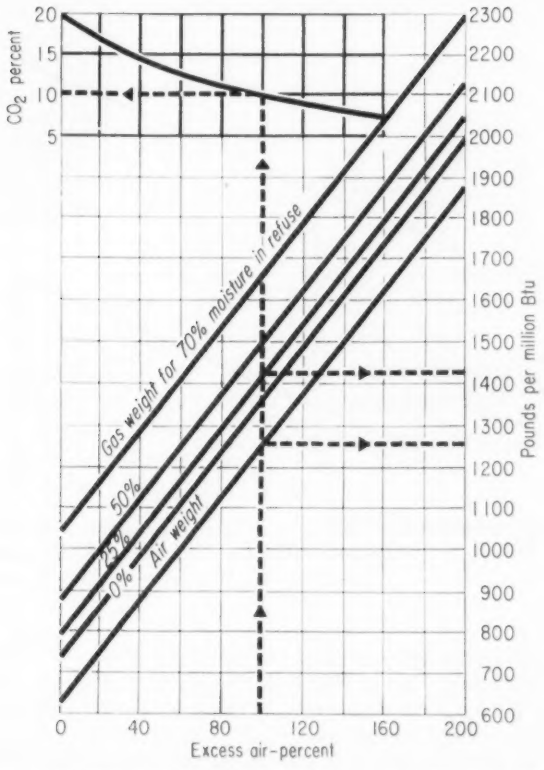
Second fault of practically all such multistage furnaces is lack of secondary or overfire air. There isn't complete combustion of either fixed carbon on the grate or unburned gas leaving the primary furnace. Experience with other solid fuels has shown that overfire air is essential to complete combustion.

To be effective, such overfire air must be introduced through properly designed and located nozzles. Fans must be used to provide velocity necessary for penetration and turbulence. Natural-draft openings sometimes present in existing incinerators can't produce this penetration and turbulence. The openings only serve to further cool an already cold furnace and, in so doing, retard combustion.

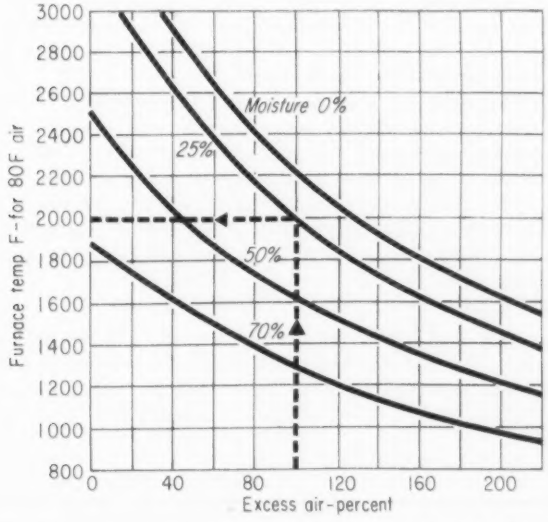
Some claim that combustion and expansion chambers act as settling places for flyash. These chambers may be equipped with elaborate baffles to aid in throwing out solid particles from the gas stream. But tests refute such claims by showing that average collection efficiency is in the 10 to 15% range, whereas at least 50% may be needed to meet existing air pollution ordinances. Further, unless deposited flyash is continually removed from the settling chambers it's almost sure to be re-entrained and carried out of the stack as gas velocity increases.

Modern incinerator design takes full advantage of knowledge gained in burning other solid fuels. With hopper-fed refuse to a traveling grate stoker, Fig. 5, p 83, the result is uniform and continuous with little or no air leakage. Grate speed, rather than opening and closing of charging gates, controls burning rate. Operators merely keep hoppers filled. Moving grate discharges noncombustible residue, keeps fuel bed clean and active. This scheme maintains higher burning rates, without excessive flyash carryover or furnace maintenance, because—unlike batch feeding—there's no need to slow down for cleaning.

Steady waste-material feed allows either manual or



2 **AIR AND GAS WEIGHTS** in lb per million Btu are easily found by chart for refuse having different moisture content



3 **INCINERATOR TEMPERATURES** can be anticipated. Chart shows how to find amount of air needed to give good control

automatic furnace temperature control close to a desired point since no air leakage occurs through intermittently opened charging gates or ashpit doors. The operation produces several advantages. Among them are (1) improved combustion, with a minimum of odor and flyash (2) reduced furnace maintenance and outage by eliminating thermal shock—chief cause of spalled brickwork and arch failure (3) need for spare units is cut with consequent reduction in equipment and building space costs.

As the moving grate carries the waste from the hopper over the air zones the fuel dries, ignites, volatile combustible is driven off and then the carbon is consumed. This progressive combustion permits close control of required air at all stages. Separate zones under the grate are adjusted to supply air where needed, while cutting down on excess air at the rear or burned out part of the fuel bed.

Traveling-grate stoker application to incinerators greatly increases their unit size and capacity. With size no longer limited by the cleaning factor—manually handled scrapers, slice bars, etc—trend is to fewer and larger incinerators at materially reduced cost and operating labor.

Greatly responsible for promoting increased use of these larger, more reliable units is some new thinking in furnace design. The modern unit may have an air-cooled suspended-refractory furnace with nonslagging carborundum blocks where needed. Or, when practical, it may have a water-cooled furnace. By and large, the unit will have an availability factor of practically 100% with time out for unscheduled repairs almost unknown.

Mechanized handling of both refuse and residue can be carried as far as desirable, depending on plant size, location, labor conditions or similar factors. Automatic control and instrumentation are practical and usually profitable. With instrumentation maintaining uniform furnace draft and temperature, burning rate and combustion air, the operator is free for other duties. Net result of these improvements in incinerator design and operation is a material reduction in first cost, maintenance and labor. And, there's a desirable increase in cleanliness, odor and flyash elimination.

Combustion products disposal problem—an important consideration—may be solved in one of several ways, depending on local factors.

Straight incineration to reduce the waste for cheaper disposal presents the problems of hot gas and flyash. Usual arrangement, as we've noted, has been to pass the gas through a series of expansion chambers. With or without baffling, the flyash was supposed to settle in these for subsequent removal. The so-called cleaned gas then passed directly to a refractory-lined stack, built high enough to avoid excessive nuisance in the neighborhood.

Power plants burning solid fuel gave up this crude layout in favor of wet or dry type dust-collection systems because of the latter's much higher efficiency. With the dry type, generally of the multicyclone design, the gas is first cooled to about 700 F by tempering with cold air, water sprays or a combination of both. The cleaned gas retains enough heat to superheat the moisture and help produce stack draft. The system's i-d fan overcomes dust-collector resistance and produces required gas velocity for efficient operation. The dry dust may then be carried to a storage vessel by conveying equipment.

Another answer to disposal lies in using a wet washer

or scrubber if a water source is available. Entering the scrubber, the waste-gas temperature is sprayed down to about 200 F. Dust is washed out by passage over a series of wetted baffles. Partly dried gas discharges through a suitable i-d fan to the stack at under 200 F. Wet flyash goes to a settling tank or pit for subsequent removal. Overall efficiency of the scrubber system is in the high 90% range. Its water requirement is about 2 gpm per million Btu per hr.

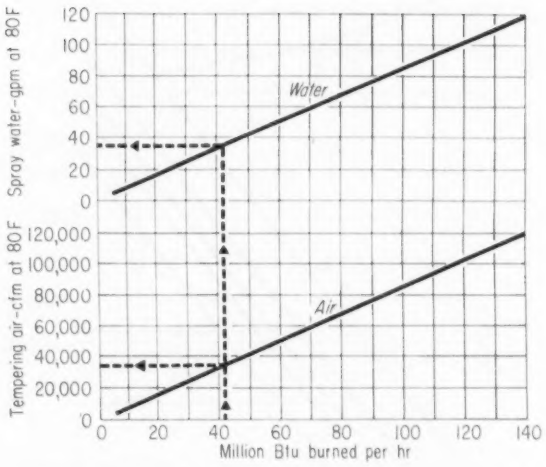
Incinerator location being suitable, another solution is use of a waste heat boiler. Here, hot gas generates steam for power or heating before going to the dust collector. However, since incinerator use is generally limited to a 5-day week, a continuous steam output would require an auxiliary fuel for week-end operation of the waste-heat boiler.

Air preheaters may be used for water-cooled furnaces, especially in connection with waste-heat boilers. However, air heaters aren't generally desirable with refractory furnaces. Preheated air may increase furnace temperature to a point that would induce slagging and maintenance problems.

Now, let's take a look at what we're going to burn in our modern incinerator. Though it may vary considerably in appearance, typical refuse is surprisingly uniform in chemical analysis. It fits into the "family tree," Fig. 1, p 80, of its close relations—wood, bark, bagasse, etc—all of which have been burned successfully for many years. Considering that paper, cartons and crates are wood, or wood products, we can use this chemical relationship to advantage. We've learned much during the past few years about efficient firing of cellulose fuels.

An authoritative report on the fuel value of refuse states: "Analysis of refuse samples burned during tests showed that the heat of combustion on a moisture and ash-free basis was very close to that of cellulose (8000 Btu per lb) regardless of the chemical composition of the fuel. This simplified heat process calculations and made it possible to predict the behavior of the material when it was burned. Most important variable was moisture, which is the burden or energy-consuming load on the incinerator."

Refuse's main constituents show an average moisture and ash-free heating value of about 8050 Btu per lb. So, for all practical purposes, we can consider industrial refuse as just another solid fuel. Instead of treating it as something unknown and mysterious we burn it just as



4 **TEMPERING** air flow or water spray requirements cools furnace gas to level needed for top dust-collecting performance

completely and efficiently as possible—as we do other solid fuels. All of them—peat, lignite, bituminous and anthracite—are derivatives of wood or similar cellulose matter even though they're a few million years older. We simply apply the modern combustion designs and practices that have made our industrial furnaces so much more economical and efficient than their predecessors.

First step is to convert refuse into heat produced in the furnace. Commonly used heat unit is the million Btu per hr—the product of fuel burned, lb per hr, times the heating value, Btu per lb as fired.

Let's assume a refuse having a moisture and ash-free heating value of 8000 Btu per lb with 25% moisture and 12.5% ash (inert material). As-fired heating value is $8000 \times [1-(0.25 + 0.125)]$ or 5000 Btu per lb.

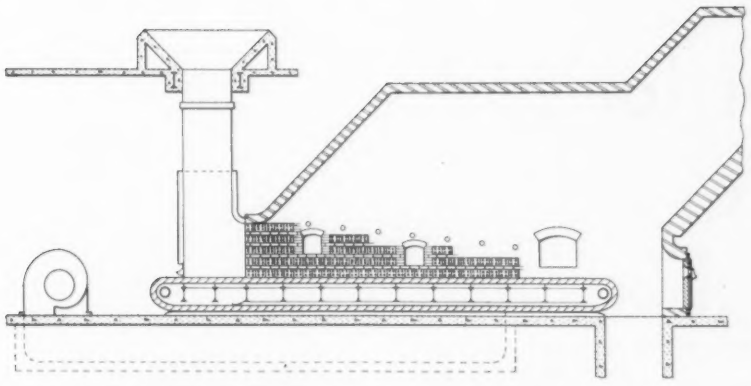
Theoretical air required for complete combustion of 8000 Btu refuse fuel is 5 lb air per lb of combustible. For 100% excess air, lb of air per million Btu becomes

$$\frac{1{,}000{,}000}{8000} \times (5 + 5) = 1250$$

Air and gas weights are measured in lb per million Btu, Fig. 2, p 81. For 100% excess air—needed to hold furnace temperature at or below 2000 F—air weight per million Btu is 1250. Adding the refuse's 25% moisture,

Typical modern incinerator design data

Refuse burned, tons per 24-hr day	50	100	150	200	250	300
lb per hr	4160	8340	12,500	16,600	20,800	25,000
Heat release, million Btu per hr	20.8	41.7	62.5	83.4	104.0	125.0
Grate area, sq ft	69.3	139.6	208	277	347	417
Furnace volume cu ft	1040	2080	3125	4160	5200	6250
Air volume, cfm	5860	10,200	15,200	20,400	25,150	30,325
Gas weight at furnace outlet, lb per hr	29,650	59,400	89,000	118,500	148,000	178,000
Gas volume at 2000 F, cfm	30,150	60,300	91,000	120,600	150,000	180,000
Flue area at 1000 fpm, sq ft	30.7	60.3	91.0	120.6	150.2	180.9



5 **MODERN INCINERATOR** with traveling grate stoker and hopper feed gives uniform fuel bed, even furnace temperatures

corresponding gas weight is 1426 lb per million Btu.

Applying these values to a 100-ton-per-24-hr design we'd have:

Lb per hr for 24-hr operation	8340 lb
Million Btu per hr (8340 × 5000)	41.7 million Btu
Grate area required @ 300,000 Btu per sq ft per hr heat release (41.7/300,000)	139 sq ft
Furnace volume @ 20,000 Btu per cu ft per hr (41.7/20,000)	2085 cu ft
Furnace height required (300,000/20,000)	15 ft
Total air weight at 100% excess air (41.7 × 1250)	52,400 lb per hr
Air volume including furnace leakage (at 100 F)	12,300 cfm
Air supplied by f-d and overfire fans at 85% of total volume	10,450 cfm
Gas weight leaving furnace (41.7 × 1425)	59,400 lb hr
Gas volume at this weight at 2000 F	60,300 cfm

Knowing gas quantity we can determine velocities in the furnace as well as required flue area for any desired gas velocity. Also, we can calculate chimney size and other design data as follows:

Vertical gas velocity above fuel bed (60,300/139)	435 ft per min
Horizontal gas velocity at furnace outlet for 8-ft width furnace (60,300/8×15)	500 ft per min
Cross-section in chimney or flue at 1000 ft per min gas velocity (60,300/1000)	60.3 sq ft

We can convert these values to a weight basis such as per ton of rated capacity, or similar units for comparison. Let's start by moving the decimal point two places over to the left in the above example—then we'd have:

One ton per day equals 83.4 lb per hr, equivalent to 417,000 Btu per hr.

Combustion air becomes 524 lb per hr per ton of rated capacity. Gas weight at 100% excess air is 467 lb per hr per ton, or 1110 lb per million Btu per hr. Combustion rate in lb per sq ft per hr is (300,000/5000) 60 lb.

Dust loading limitation set by the ASME model code (0.85 lb flyash per 1000 lb gas at 50% excess air) converts to 0.85 × (1110/1000), or 0.943 lb per million Btu.

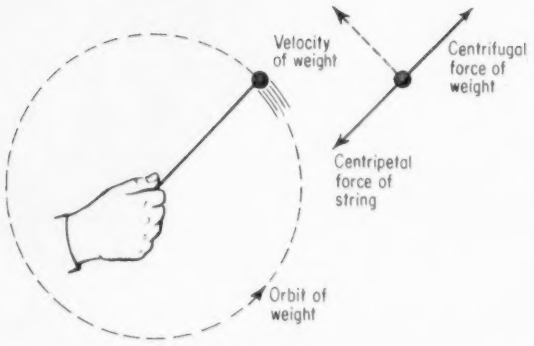
Fan sizes are easily obtained by using these air and gas volumes together with static pressures based on test data and adding the standard fan tolerances in line with conventional power plant practice.

With these calculations, it's not difficult to compensate for variations in the unit heat value, which can affect all other results. Example: For an as-fired 4000 Btu refuse having 50% moisture plus ash content, total heat input becomes 33.4 million Btu per hr. For industrial refuse, which may average 6000 Btu per lb as fired, this heat input becomes 50 million Btu per hr. Design, therefore, should be based on the highest average unit heat value expected, and the resultant million Btu total is that used in subsequent calculations.

It becomes obvious that equipment selection and sizing furnaces, flues, dust collectors, fans and stacks on the above basis isn't difficult. It's both easier and sounder than the former empirical hit-or-miss selections that had no common denominators or those based on complicated parameters and logarithmic functions. Too, this method permits easy comparison of several installations on the basis of Btu per sq ft of grate or per cu ft furnace volume. Flyash emission or dust loading is easily related to million Btu per hr fired, or to unit gas weights. Table, p 82, shows typical examples.

Furnace temperature, tempering air or water-spray requirements for gas cooling, and similar data are also easily determined on this million Btu basis. Fig. 3, p 81, shows furnace temperatures obtained with various excess air and moisture contents. Fig. 4, p 82, shows air and water requirements for tempering the gas.

Power for space



1 Satellites move like weight whirling on end of string; weight wants to go in straight line but string pulls it into orbit

What new ideas do we have to learn to travel in space? What makes a rocket move? Here we have a quick rundown on the basics of space travel and special problems of the rocket-power engineer

By B G A SKROTZKI, Associate Editor

Today we are just beginning to move the frontiers of civilization to the far reaches of outer space. This advance will not be won easily. Though we know what we must do to meet the basic laws governing space travel, we face a staggering energy-supply problem. First, let's review the laws.

Newton's genius and painstaking study uncovered the laws of motion and gravity that explain the behavior of our planets and their satellites, see panel, below. Russia's sputniks jumped the gun in the Geophysical Year to dramatically demonstrate the soundness of these laws and to start the exploration of "outer" space.

Space travel. We have two versions of space travel: (1) Satellite orbiting about the earth, in which a body travels in space around the earth but is tied to it by the force of gravity. (2) Complete escape from the earth, in which a body speeds away until the force of gravity becomes negligible or at least balanced by the forces from other planets, satellites and the sun.

What are the mechanics of satellite motion? For a quick answer, swing a stone on the end of a string, Fig. 1. Because of its motion the stone has kinetic energy and it obeys the first law (inertia) by trying to travel in a straight line. But the string tugs at the stone with a centripetal force that makes it travel in an orbit. You generate the centripetal force which balances the centrifugal force you feel through the string generated by the orbiting stone; here we have the third law—action equals reaction.

This closely parallels what happens to our natural satellite, the moon. Instead of a string the invisible force of gravity tethers the moon to the earth, see law of gravity, panel left. The moon's massive kinetic energy coupled with its diversion from a straight-line course creates a centrifugal force that balances the centripetal force of gravity tending to pull the earth and moon together. Fig. 2 shows that the moon in a paradoxical sense continuously "falls" to the earth—without ever reaching it.

If the pull of gravity could be cut off at A, the moon would go off in a straight line towards C. But the force of gravity g keeps tugging at the moon to make it travel in its orbit to B. In a real sense we can say that the moon falls from C to B in traveling through the part of its orbit from A to B.

If the moon slowed up it would create a smaller centrifugal force. This would be overbalanced by the force of gravity and the moon would spiral towards the earth for a tremendous collision. On the other hand, if the moon went faster, its centrifugal force would overbalance the centripetal force of gravity, and it would spiral away from the earth and escape to outer space.

Satellite speeds. We can place a satellite in an orbit

Basic laws for rockets and satellites

Newton's three laws of motion:

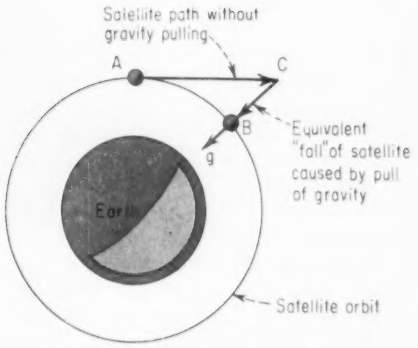
1. **Law of inertia.** A moving body travels in a straight line (and a stationary body stays at rest) unless acted on by an unbalanced force.

2. **Law of momentum.** Acceleration of a body varies directly with the unbalanced force acting on the body and inversely with the mass of the body.

3. **Law of reaction.** For every force acting on a body (action) there is an equal and opposite force acting on another body (reaction); or action equals reaction.

Newton's law of gravity:

The force of attraction between two bodies varies directly with the mass of each body, and inversely as the square of the distance between their centers.



2 Force of gravity keeps satellite tied to earth, making it "fall" toward earth in an orbit that has constant altitude

3 High-altitude satellites move slower, turn less in their orbits in given time, must move in plane through earth's center

4 Multistage rocket must exert steady force on payload to get it up to speed needed, stages fire in succession without pause

at any altitude above the earth if we give it the right speed. Fig. 5 shows what the orbit velocity should be for altitudes from 0 to 25,000 miles. At zero altitude this is about 26,000 fps or 17,700 mph, assuming that air friction is zero. The satellite would make one complete circuit around the earth in about 85 minutes.

At 1000 miles altitude (5000 miles from the earth's center) the satellite speed must be 23,300 fps or 15,900 mph for the centrifugal force to balance the force of gravity. At this altitude the force of gravity is only $(4000/5000)^2$ or 64% of its pull at the surface of the earth; the satellite circles the earth in just under two hours.

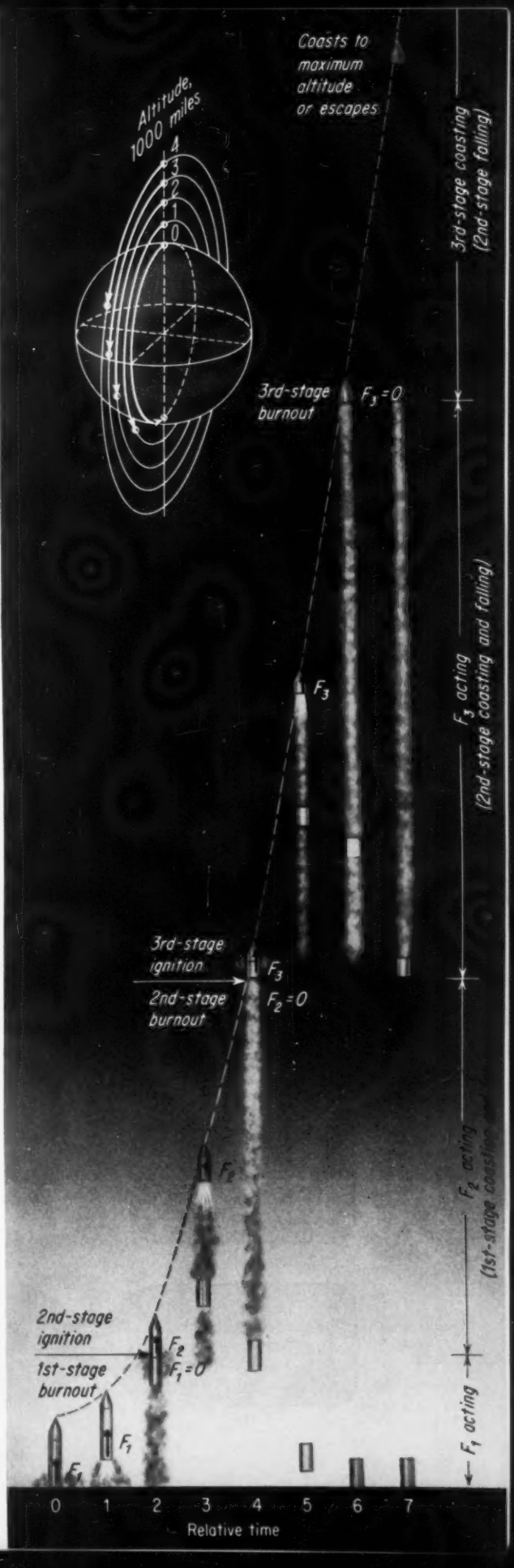
A satellite about 22,500 miles above the earth has an orbit velocity of 10,000 fps or 6800 mph and circles the earth in just 24 hours. Gravitation force shrinks here to 2.3% of its surface pull. If this satellite is above the equator headed in the same direction that the earth turns on its axis, it would always be in the same place in our sky, day and night.

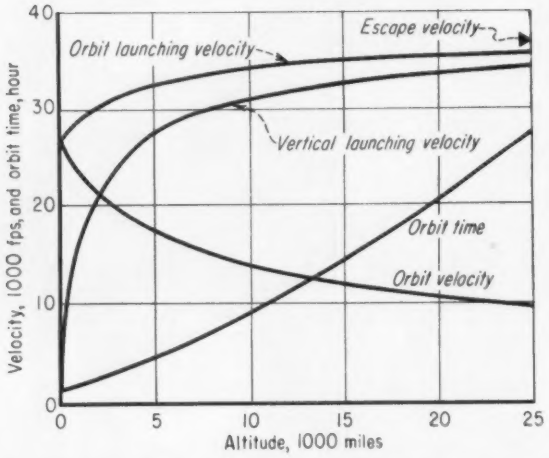
At 240,000 miles altitude a satellite circles the earth in 28 days—you'll recognize this as the moon. Remember, for all orbits in Fig. 5 the centrifugal force of the satellite just balances the centripetal pull of the earth.

Fig. 3 compares satellite speeds for altitudes of 0 to 4000 miles. While the surface satellite makes a half revolution around the earth (180 deg) the higher ones successively make less of a turn; the one at 4000 miles makes only 0.177 turn (63.7 deg) in the same time.

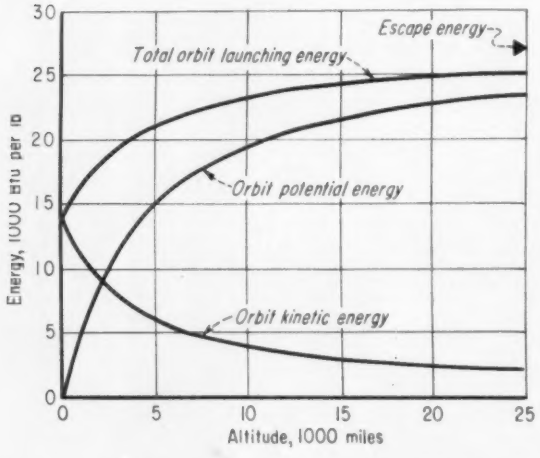
Vertical speeds. Fig. 5 also shows the vertical launching speeds we would have to give a body to reach the altitudes shown. These speeds rise very rapidly up to an altitude of 5000 miles and then increase more gradually for higher altitudes. To completely escape the earth a body must be launched at the terrific speed of 36,900 fps or 25,100 mph.

These velocities represent the kinetic energy we first





5 Orbit launching velocity includes effect of vertical launching velocity and orbit velocity needed to stay aloft in orbit



6 Orbit launching energy equals sum of potential and kinetic energies for any given altitude; gravity fades with altitude

give the body. As the body rises it slows down—the kinetic energy converting to potential energy. When the body stops at its peak altitude all the kinetic energy has converted to potential energy. It then falls back to earth and the potential energy reconverts to kinetic as the body speeds up. Without air friction, the landing kinetic energy would equal the initial launching kinetic energy. Actually air friction absorbs some of the kinetic energy and might be so great as to burn up the body if it travels at high enough speed, going up or down.

Satellite launching. To get a satellite up in the sky from the earth's surface, we have to give it enough speed to (1) suit the orbit it will take and (2) hoist it up to the orbit altitude. Total launching velocity is less than the sum of orbit and vertical launching needs, because we can aim the rocket at an angle for best performance.

The kinetic energy needed by a satellite to stay in its orbit fixes the orbit velocity. On the other hand, the vertical velocity component depends on the potential energy the satellite must have when it reaches its orbit altitude. During its launching the satellite must be given the sum of these two energies.

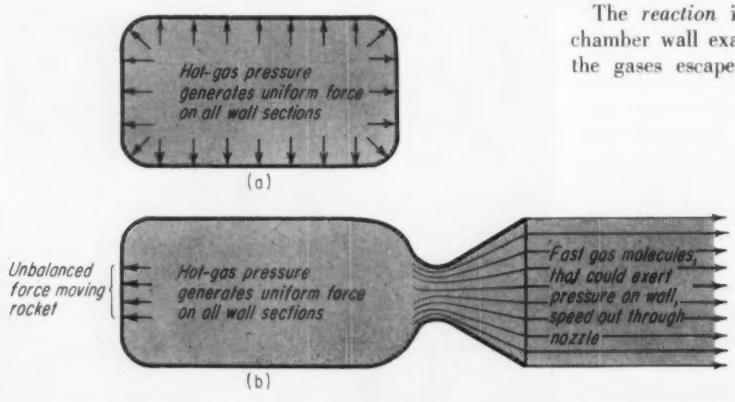
Fig. 6 shows the two components and their total for altitudes up to 25,000 miles. Zero altitude satellites must have 13,600 Btu per lb of mass when launched. At the other extreme, for complete escape we have to give satellites, or rather space travelers, just double this energy, or 27,200 Btu per lb mass.

As orbit altitude increases, the orbit kinetic energy drops, but potential energy rises. Growth of potential energy is faster than kinetic energy shrinkage, so the total energy grows with rising altitude to a maximum of 27,200 Btu per lb at complete escape.

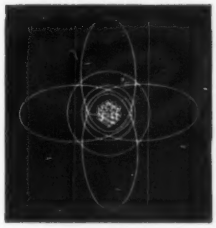
Rockets launch our artifical satellites into their lofty orbits. A rocket's operating principle uses the third law of motion—reaction equals action. Motive power develops in a combustion chamber with an exit hole or nozzle in one end.

The chamber burns either a mixture of solid fuel and oxygen or liquid fuel and oxygen (propellants). The solid propellant is placed as a complete charge in the chamber, while liquid propellants are sprayed in by pumps. Their combustion products develop pressures ranging from 300 to 2000 psig and temperatures of about 4000 F. These measure the tremendous kinetic energy of the gas molecules that scream out through the nozzle at the rocket rear. The momentum of the escaping gases represent the direct *action*.

The *reaction* is an unbalanced force acting on the chamber wall exactly opposite the nozzle through which the gases escape, Fig. 7*b*. (*Continued on page* 186)


Hot-gas pressure generates uniform force on all wall sections
(a)
Unbalanced force moving rocket
Hot-gas pressure generates uniform force on all wall sections
Fast gas molecules, that could exert pressure on wall, speed out through nozzle
(b)

7 Rocket works on Newton's third law of motion: action equals reaction. Unbalanced reaction force propels rocket, gets bigger with chamber pressure, temperature



Nuclear notes

By B G A SKROTZKI, Associate Editor

Placing any bets on the best reactor? Don't, says the Technical Appraisal Task Force on Nuclear Power of the Edison Electric Institute, it's too early to pick the most likely reactor. This committee, made up of top-flight utility executives and headed by J F Fairman, senior V P of Con Edison Co of N. Y., calls for more research and development along several lines and building more reactors ranging in size from experimental to full-scale power units.

Study these reactor designs, says Task Force, and build if they look promising when compared to conventional power costs: (1) Boiling water with nuclear superheat, 10-50 mw, 1958-1962; (2) Gas-cooled graphite-moderated, 50 mw, 1959-1963; (3) Aqueous homogeneous solution, 75-150 mw, 1959-1964; (4) Fused-salt fueled, 10 mw, 1959-1964; (5) Steam-cooled heavy-water-moderated, 10 mw, 1959-1965; (6) Intermediate-energy-neutron breeder, 10 mw, 1958-1967; (7) Pressurized-water enriched-uranium fuel, 200 mw, 1959-1965; (8) Boiling-water enriched-uranium fuel, 200 mw, 1960-1966; (9) Light-water-cooled graphite-moderated Hanford type, 250 mw, 1959-1966; (10) Heavy-water cooled and moderated, Savannah-River-type natural uranium, 250 mw, 1960-1967; (11) Sodium-cooled graphite-moderated, 200 mw, 1961-1967. Several of these would be "second-generation" reactors to be built if past experience with first generation shows way to significant cost reductions. Ditch any of these designs as soon as they show they can't pay off, Task Force adds.

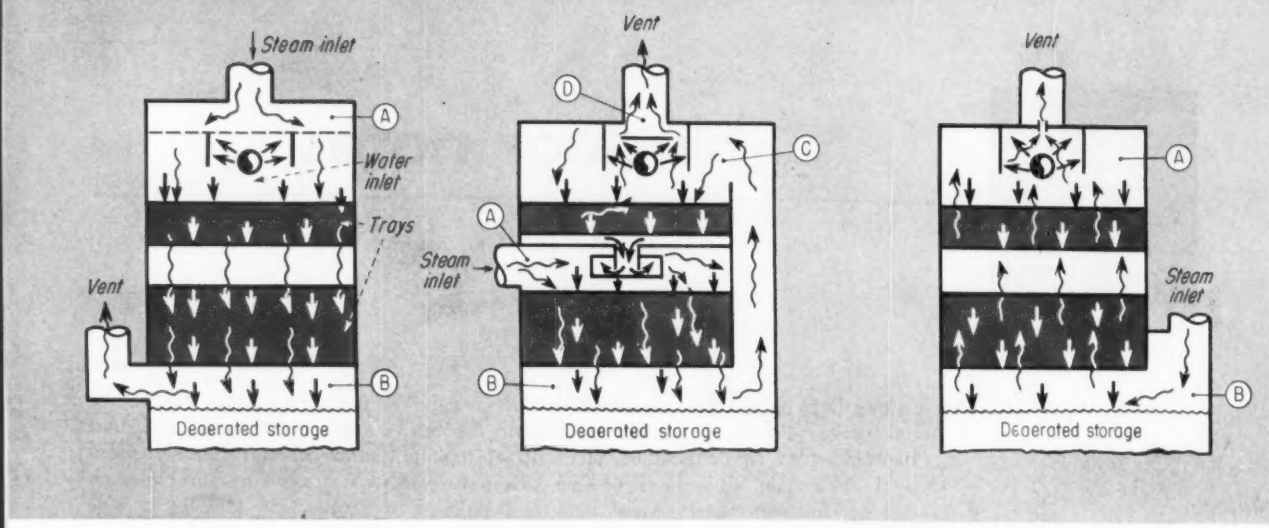
High-level radiation use in industry will be studied by contractor for AEC, who wants to uncover more uses in drug, chemical, plastics and other fields. Study will survey present uses and forecast (1) growth of fission-byproduct radiators (2) demand for space in high-level gamma irradiator (3) competition of other methods.

New boiling-water reactor plant projected by Pacific Gas and Electric Co will be rated at 50 mw and have capability of 60 mw. Bechtel Corp will design and build it on fixed-price basis for start in 1962. Plant, on Humboldt Bay near Eureka on northwest tip of California, is expected to produce competitive power at 8.7 mills per kwhr initially, with later chance of lowering costs to 8.1 mills. General Electric, who will build reactor, expects fuel-element life up to four years. Reactor will produce steam on single cycle at 1000 psig and 545 F. PG&E hopes to build 200-mw nuclear plant when projected costs run about 6.5 mills per kwhr.

Experimental Breeder Reactor No. 2, developed by Argonne National Laboratory, will be built at Idaho Falls for AEC by H K Ferguson Co of Cleveland to start in 1960. The 62.5-mwt reactor will produce a net 17.5 mwe. This fast-breeder plant includes an integrated fuel-processing plant for recycling the fuel. The unmoderated sodium-cooled reactor uses tandem loops to generate steam at 1250 psig and 850 F.

Second-try invitation by AEC to build 22-mwe boiling-water reactor for Elk River, Minn. received responses from General Electric Co and ACF Industries. Plant will have conventional fuel-fired superheater.

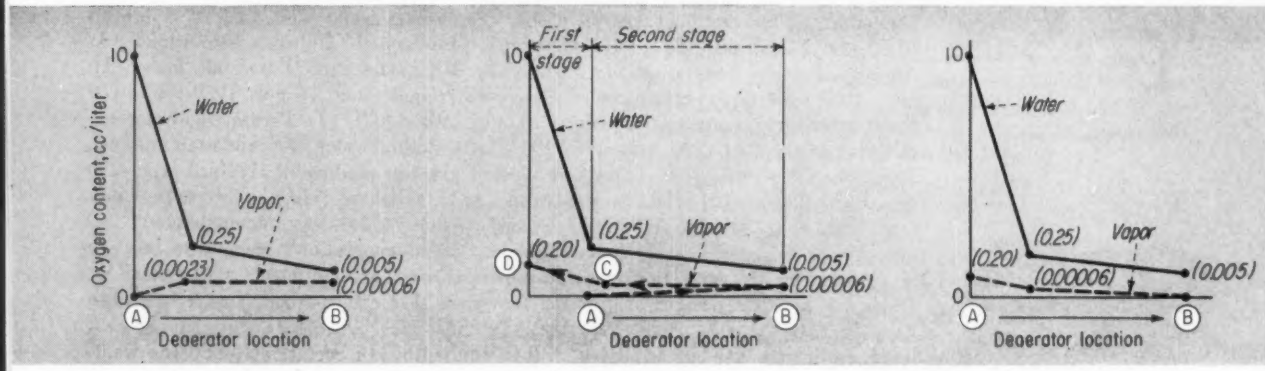
Growing uranium-ore reserves make U.S. independent of foreign sources. At end of 1954 we had about 10 million tons in sight; at end of 1956 this grew to 60 million and today we have about 78 million. This ore contains about 0.27% U_3O_8. New Mexico leads in reserves with 53.3 million tons. During 1957 we processed a total of 3.6 million tons. We can bank on reserves growing in future.



PARALLEL downflow deaerator draws noncondensables to bottom of tray stack

TWO-STAGE downflow deaerator draws less noncondensable gas to bottom of trays

COUNTERFLOW deaerator keeps almost all noncondensable gas away from tray bottom



1 Dotted line gives equilibrium oxygen content of vapor in contact with water

2 Vapor equilibrium oxygen and oxygen in water are traced through deaerator

3 Equilibrium oxygen of vapor in contact with water is zero at bottom of trays

Even without exact test data, you can easily . . .

Evaluate your deaerator performance

By A E KITTREDGE, Mechanical Engineer

In one sense, the deaerating feedwater heater is difficult to evaluate compared to boilers, turbines and pumps where there's a wealth of test data available.

But the deaerator doesn't have to be a mysterious device. Its performance can be easily evaluated even without exact test data. There are well-defined bounds for deaerator operation. And there are laws for projecting known deaerator results from one operating condition to another.

Careful evaluation pays off for both consultants and users by insuring top-notch performance. In spite of this, many engineers still talk about intangible virtues of tray surface and spilling edge, where a sound engineering evaluation of results based both on theory and engineering practice is needed.

Deaerator design. Three designs are shown above. Deaerator at left is a simple single-stage downflow type. Steam and water enter at the top and flow down over trays. Noncondensable gases are vented from bottom.

Fig. 1 compares the dissolved oxygen of water going through this unit with equilibrium oxygen of vapor in contact with the water. Oxygen quantities shown are typical for the parallel-downflow design operating on 100% cold makeup water with an operating pressure of 10 psig and an outlet temperature of 240 F. Water entering contains 10 cc/liter oxygen. Steam coming in is essentially free of

These curves help you check deaerator results at various loads

Deaerating heaters with unknown tray details can be evaluated by calculating effluent dissolved oxygen at various operating conditions and checking against guaranteed results.

(1) Use Fig. 4 to estimate oxygen content of water after spraying. Subtract guaranteed oxygen residual to get the concentration change through the tray stack.

(2) Next, calculate the number of transfer units, TU, needed to meet guaranteed performance.

$$TU = \frac{\text{Concentration change}}{\text{Log mean driving force}}$$

Driving force at any point in tray stack is difference between water's actual and theoretical oxygen content. Then calculate Log mean driving force, LMDF.

$$LMDF = \frac{(\text{Maximum} - \text{Minimum driving force}}{2.3 \text{ Log } \frac{\text{Maximum driving force}}{\text{Minimum driving force}}}$$

Maximum driving force is at the top of the tower and minimum at the bottom. Use Fig. 5 to estimate theoretical dissolved oxygen at 1% vent rate. This reading must be multiplied by the oxygen released. Curve is based on the formula:

$$\text{Theoretical } 0_2 = \frac{0_2 \text{ released (Operating pressure) (0.0001)}}{\% \text{ vented}}$$

(3) Solve for the product of h, number of tray layers, and e, tray efficiency per layer at 68 F:

$$h\,(e) = TU\,(v^{4}/^{3})$$

where v = viscosity in centipoises.

(4) Then multiply h (e) by $\left(\frac{w}{W}\right)^{.263}$ Flow rate at known or guaranteed conditions is W. New flow rate is w.

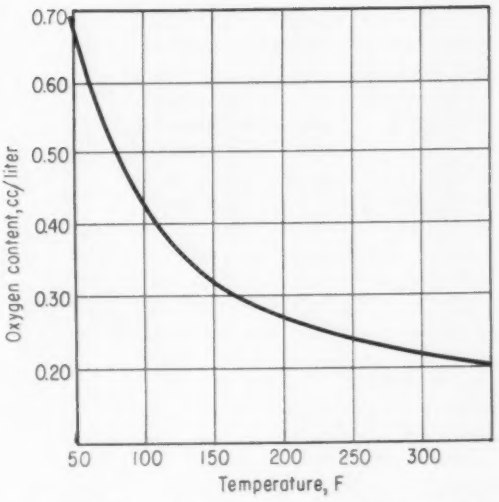
(5) Now use revised value of h (e) and $v^{4/3}$ to calculate the new number of transfer units needed.

(6) Again use Fig. 4 to estimate oxygen content after spraying for the new conditions.

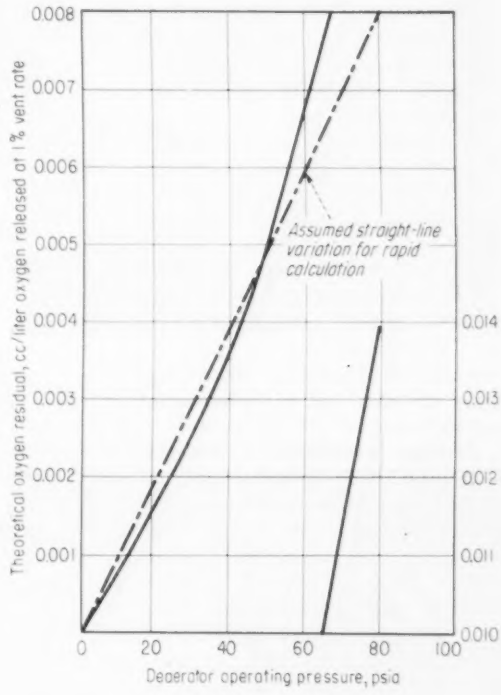
(7) Compute the residual gas fraction, RGF:

$$\text{Log RGF} = \frac{-TU}{2.3}$$

(8) Finally compute residual oxygen for the revised operating conditions. Effluent 0_2 = RGF (0_2 residual after spraying) plus theoretical 0_2.



4 Amount of dissolved oxygen remaining in the water after initial spraying in deaerator decreases with temperature



5 Theoretical oxygen residual depends on amount of oxygen removed, rate of venting and operating pressure

all noncondensables. Equilibrium-oxygen content of vapor in contact with water in the spray compartment builds up to 0.0023 cc/liter. At the same time dissolved oxygen in water drops to 0.25 cc/liter. After passing over the tray stack, deaerated-water oxygen residual is only 0.005 cc/liter. But vapor equilibrium oxygen remains substantially 0.0023 cc/liter.

To produce these results the deaerator must have an extremely large vent condenser. This one is actually sized to do 50% of the heating job giving a vent vapor flow equal to 8% of effluent capacity. Even with this favorable venting, the unit is considerably limited by high noncondensable gas concentrations at bottom.

Fig. 2 gives oxygen content of both vapor and water for the 2-stage

downflow tray design. The graph is marked to identify corresponding deaerator location above. Note that all noncondensable gas concentrations are much lower.

The unit has two separate stages separated by a water seal. Water is sprayed into the first stage for initial heating. First stage also serves as a vent condenser for the second deaerating stage.

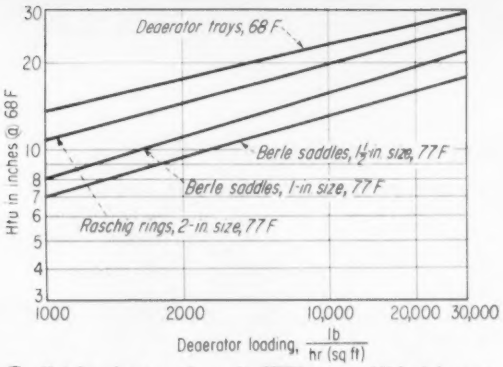
Noncondensable gas concentration at bottom of second tray stack corresponds only to those gases removed in this stage. Since about 90% of the gases are released in first stage, residual noncondensable-gas partial pressure is low compared to a parallel-downflow design. So gases of moderate solubility such as oxygen, hydrogen and nitrogen are easily handled. But design is still handicapped for removing the more-soluble gases such as ammonia or carbon dioxide.

Ideal arrangement from an equilibrium standpoint is a pure counterflow design. Fig. 3 shows an equilibrium oxygen content of zero for vapor in contact with water at deaerator bottom.

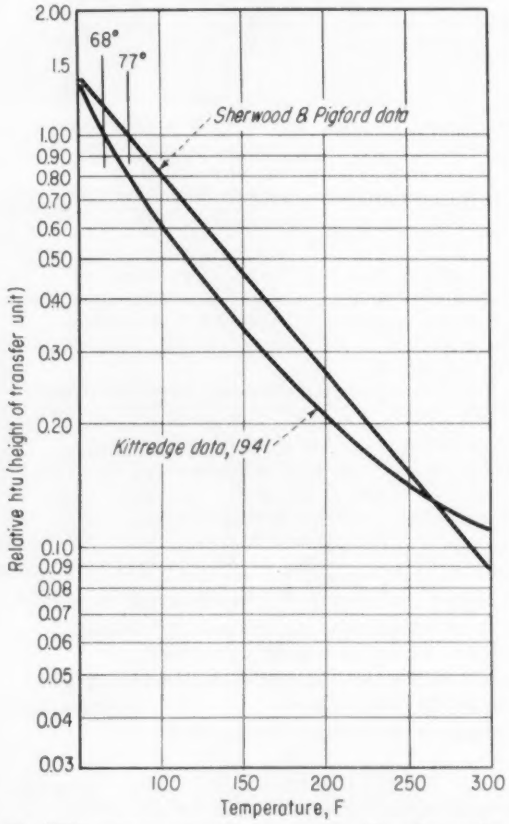
Gas-removal theory. Now let's look into the actual mechanism of gas removal from water in a deaerator. High gas concentrations are removed by a sudden heating or a sudden reduction in pressure. Water is sprayed into steam-filled space or a vacuum. In both cases about 90 to 95% of dissolved gases in water are released by ebullition. Remaining gases are taken out by diffusion in the tray stack.

Primary ebullition is brought about by a sudden destruction of the internal-external pressure stability of the water particle. As it exists free in nature, each gas-saturated water particle has an internal pressure equal to external atmospheric pressure. Internal pressure is the sum of water-vapor pressure and gas pressure. Concentration of each gas in solution equals its solubility in water at that temperature multiplied by pressure of that gas in the atmosphere.

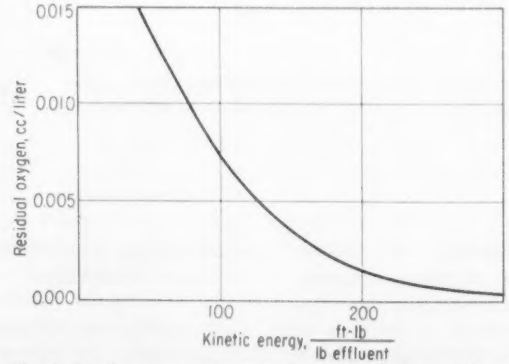
When internal water-vapor pressure is suddenly increased by heating, violent gas ebullition occurs and a heavily saturated water solution is unburned of a large part of its gas concentration. Same effect is observed when ex- (*Continued on page* 204)



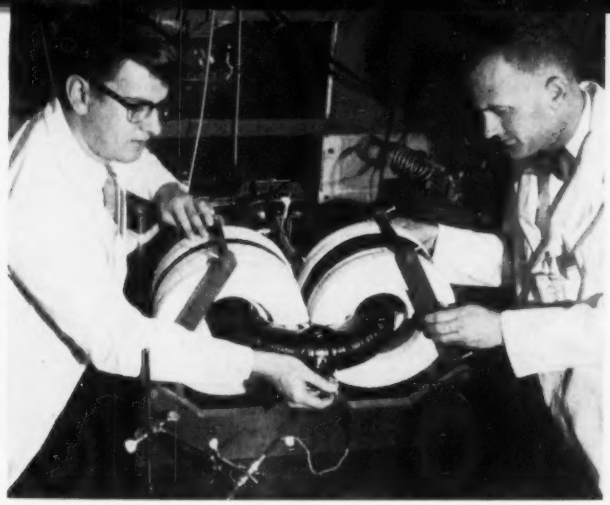
6 Height of a transfer unit, HTU, is established by test. It depends on loading, type packing and other variables



7 HTU varies greatly with temperature. Kittredge results agree generally with later tests by Sherwood and Pigford

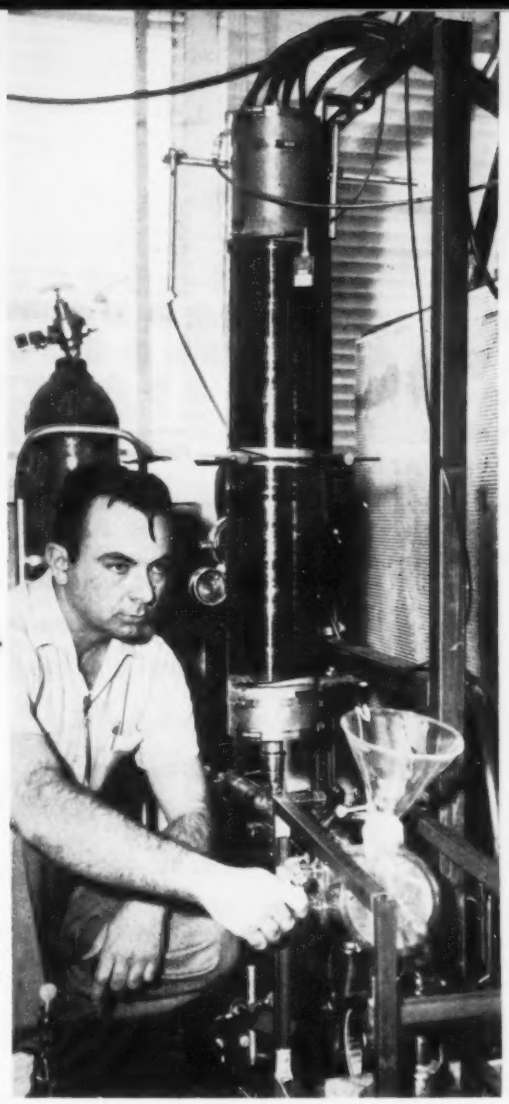


8 Residual oxygen varies with kinetic energy in atomizing deaerators with spring- or weight-loaded steam valves



PERHAPSITRON of our Los Alamos Atomic Laboratory holds heavy hydrogen at low pressure in doughnut tube passing through two solenoids

COLUMBUS S-4 in Los Alamos Laboratory has erect coiled tube holding heavy hydrogen which undergoes fusion reaction to release energy



Are we on the road to fusion power?

We're barely at the beginning—and even then unsure of ourselves. Both British and U.S. scientists have produced temperatures of about 11 million F in their fusion reactors. They're not certain whether most of the neutrons ejected by their reactors or "pinch" tubes come from thermonuclear reactions or from electrically accelerated fusion processes.

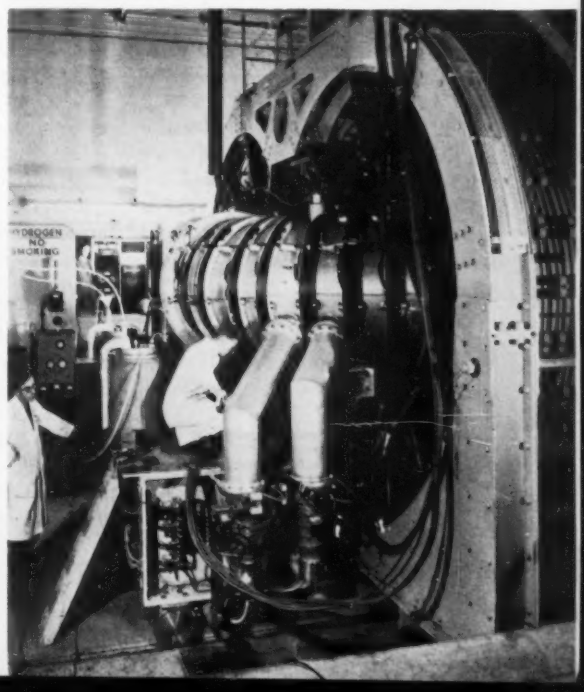
Pulsing hundreds of thousands of amperes through the rarefied heavy hydrogen from the kick of hundreds of kv forms the superhot plasma of deuterium, electrons, neutrons and protons. Magnetic field of the heavy current acts as a "bottle" to pinch the plasma into a narrow thread. The high voltage sets up a strong electric field that terrifically accelerates the electrons and positive ions (hydrogen nuclei) in opposite directions which make up the heavy current through the gas or plasma.

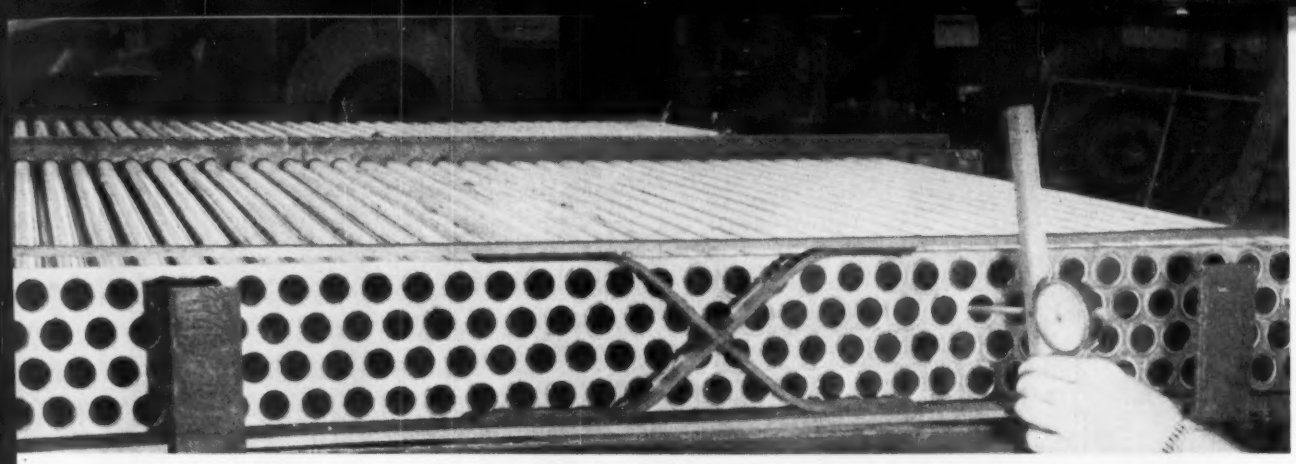
When fast deuterium particles (heavy-hydrogen nuclei) collide, some of them fuse to form helium-3 and a free neuron, at the same time, changing a minute part of their mass to energy as heat (motion). If the heat speeds up other deuterium particles and they fuse to change mass to energy in a chain reaction, we're in business with a steady power-yielding thermonuclear reaction.

But if the deuterium speeds up only because of the high-voltage push, we just have separate fusion reactions which are one-shot deals. Their heat release is not enough to keep a chain reaction going. Particle accelerators have been making one-shot fusions for some years. The pinch-tube reaction only lasts for a millionth of a second.

How far away is the goal? Our researchers estimate that they will have to produce about 400 million F in a successful reactor. They've only reached 11 million F so far.

ZETA of Britain's AERE keeps heavy hydrogen for fusion reaction in doughnut tube wound with wires to make field





TUBE-SHEET DISTORTION is measured with dial micrometers. About 30 readings cover the face profile of each tube sheet tested

What effect does weld sequence have on distortion? How strong are welded tube-to-tube-sheet joints? Part 2 of a 3-part series studies distortion and mechanical strength of joints made by . . .

Welding copper-base alloy tubes

By J F SEBALD and L H HAWTHORNE*

Last month the overall test program was outlined together with data and conclusions for Section I. This month we take up Sections II and III, dealing mainly with tube-sheet distortion from manual and machine welding. The effect of consecutive and skip welding sequence is studied along with mechanical strength of tube-to-tube-sheet joints.

Welding. Section II includes four tube-to-tube-sheet assemblies. Tube sheets are copper silicon measuring $\frac{7}{8}$x4$\frac{3}{8}$x48 in. Two units, Parts A and C, are manually welded. Remaining two units, Parts B and D, are machine welded for comparison.

Consecutive welding sequence is used for Parts A and B, while Parts C and D use a skip sequence. Both are shown in Fig. 1.

Section III involves seven additional tube-to-tube-sheet assemblies. Measurements from Section II show less distortion with skip-sequence welding, so skip sequence only is used for Section III.

Tube-to-tube-sheet assembly made for Section II D has the same material combination called for in Section III B. Since it's skip-sequence welded, this unit can be used again. Complete welding details were given last month. Note that with aluminum-brass tubes the shielding gas was a mixture of helium and argon. This was done because earlier experience showed that wherever aluminum was present either helium or a mixture of helium and argon gave the best welding results with straight-polarity direct current.

In spite of the fact that the preferred shielding gas is argon such as used in Section III F, a mixture of argon and helium was used for III H. The original bottle of argon exhausted and the replacement bottle seemed to be of inferior purity. It was impossible to obtain satisfactory welds without diluting the impure gas with helium. The same thing happened when pure argon was in short supply because of labor trouble. Adding helium to the shielding gas does reduce amperage enough for satisfactory control of the weld metal. But the decrease in welding current causes a reduction in the depth of weld penetration. And as the test data shows, weld strength drops.

Running the test. Section II includes preliminary welding-distortion tests. Distortion readings are taken at the midpoint of the tube sheet strips and summarized.

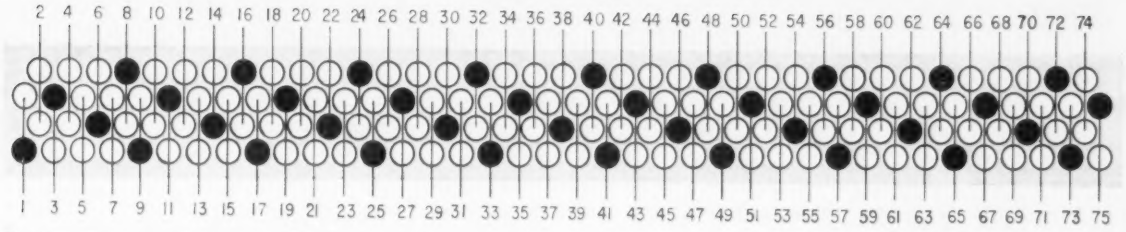
All these measurements are made with dial micrometers referenced from a fixture that's indexed from specific points on the face of the tube sheets. About 30 readings are needed to find the face profile of each tube sheet tested.

Distortion (lack of flatness) after machining is considered zero. This is the reference plane for distortion normally associated with tube installation. Positive and negative signs are used to indicate the direction of tube-sheet movement.

Positive values are for movement toward the back of the tube-sheet strip. Negative values mean movement toward the face or front of the sheet. Measurement taken is the net

*J F Sebald is Chief Engineer, Condenser and Heater Section, Worthington Corporation. L H Hawthorne is Manager, Welding Section, Research Department, Revere Copper and Brass Inc. Article is based on the authors' part in a panel on "Welding of nonferrous tubes to tube sheets," 1957 ASME annual meeting in New York

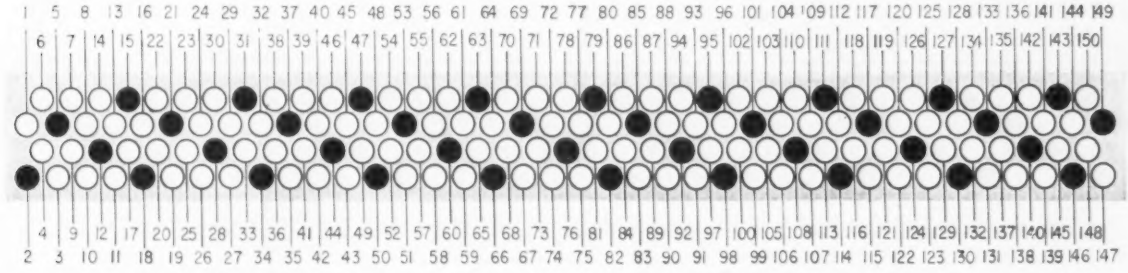
Welding tubes in skip sequence reduces tube-sheet distortion



Start

1	7	70	9	45	54	17	74	32
73	67	16	69	39	30	59	8	44
37	13	58	15	6	48	23	68	38
19	61	22	63	72	36	53	14	
55	25	52	21	12	42	29	62	
10	49	34	57	66	5	47	20	
64	31	40	27	18	71	35	56	
28	43	3	50	60	11	41	26	
46	4	75	33	24	65	2	50	

1 Section II of test program studied effect of tube-installation sequence on tube-sheet distortion. Heat-exchanger units made for Parts A & B used consecutive sequence, below. Parts C & D tested units using skip sequence, above. Chart, left, outlines this order of welding. Numbers correspond to those on drawing, above. Distortion measurements on all Section II assemblies prove that skip sequence does minimize the effect of tube-sheet distortion. So all other units made for Section III used this preferred or skip-welding sequence. Tubes in solid black are not rolled. All others in the sheet are both welded and rolled.



change occurring as a result of each complete operation. From these values total mechanical and overall distortion are computed. Mechanical distortion is the algebraic sum of movements produced solely by mechanical operation. Total includes both mechanical- and welding-distortion effects. Energy input in watt-seconds per welded joint is taken for each welding method and procedure. Temperature measurements taken are too inaccurate to be useful.

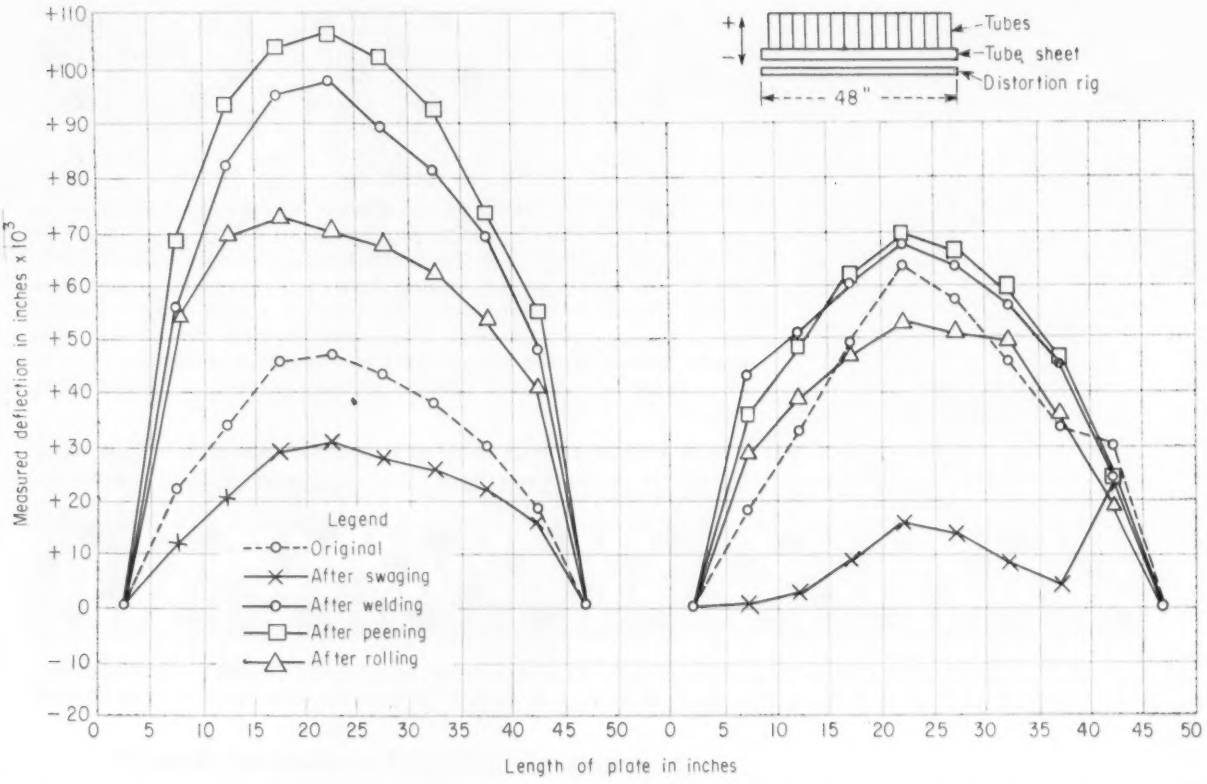
One main purpose of Section II is to compare consecutive and skip-sequence welding procedure from the standpoint of distortion control. Since skip-sequence welding does produce less distortion it was selected as the preferred method for Section III.

Mechanical strength of the welded and rolled joints for different welding and tube-installation procedures is tested. Three strengths are tabulated for each condition, in percent of minimum specified tensile strength of the tube material. Those at which a preponderance of failures occur are the median strengths. High and low values show the range of

Summary of tube-joint mechanical strength

Test	Force	All tubes welded and . . .	Tube tensile strength (% of specified minimum)			Welding sequence	Materials		Tube sheet thickness, inches
			Minimum	Median*	Maximum		Tube	Tube sheet	
IIA	Tension	Not rolled	67.3	87.5	108	Manual, consecutive	Admiralty	Cu-Si	⅞
	Tension	Rolled	80.5	101.5	108				
	Compression	Rolled	101.5	124	150				
IIB	Tension	Not rolled	89	108	108	Machine, consecutive	Admiralty	Cu-Si	⅞
	Tension	Rolled	67.3	108	130				
	Compression	Rolled	150	157	180				
IIC	Tension	Not rolled	75	82	101	Manual, skip	Admiralty	Cu-Si	⅞
	Tension	Rolled	75	87.5	101				
	Compression	Rolled	115	131	149				
IID	Tension	Not rolled	82	103	117	Machine, skip	Admiralty	Cu-Si	⅞
	Tension	Rolled	89	103	124				
	Compression	Rolled	136	163	197				
IIIA	Tension	Not rolled	74	97.5	104	Machine, skip	Al-Br	Cu-Si	⅞
	Tension	Rolled	72.5	102	112				
	Compression	Rolled	91.5	142	159				
IIIB	Tension	Not rolled	82	103	117	Machine, skip	Admiralty	Cu-Si	⅞
	Tension	Rolled	89	103	124				
	Compression	Rolled	136	163	197				
IIIC	Tension	Not rolled	91.5	104	124	Machine, skip	Al-Br	Cu-Si	1½
	Tension	Rolled	91.5	118	129				
	Compression	Rolled	154	161	170				
IIID	Tension	Not rolled	89	94.5	108	Machine, skip	Admiralty	Cu-Si	1½
	Tension	Rolled	66.5	101.5	115				
	Compression	Rolled	135	178	194				
IIIE	Tension	Not rolled	49	68	88	Machine, skip	Al-Br	Naval brass	⅞
	Tension	Rolled	49	68	80.5				
	Compression	Rolled	79	106	117				
IIIF	Tension	Not rolled	61	82.5	101.5	Machine, skip	Admiralty	Naval brass	⅞
	Tension	Rolled	67.3	82	96				
	Compression	Rolled	122	136	170				
IIIG	Tension	Not rolled	61.5	74	80.5	Machine, skip	Al-Br	Naval brass	1½
	Tension	Rolled	68	74	104				
	Compression	Rolled	74	124	155				
IIIH	Tension	Not rolled	56	70	108	Machine, skip	Admiralty	Naval brass	1½
	Tension	Rolled	67	89	101.5				
	Compression	Rolled	133	164	191				

*Strength coincident with maximum number of failures



2 Here's how tube-sheet distortion profiles compare for Section IIC and IID. Machine welding, right, produced less distortion than manual welding, left. Both tests used skip welding sequence with admiralty-metal tubes and ⅞-in.-thick Cu-Si tube sheets

strength developed. Each set of three figures is based on about 30 samples.

In Section III, distortion and mechanical-strength tests are continued. But skip-sequence machine welding is used. And energy input in watt-seconds is adjusted to produce welds of consistently high quality with differing materials and tube-sheet thickness. Energy input is measured and compared with welding distortion. Two straight-line regressions are developed. One is independent of material combination but dependent on thickness of tube sheets. The other is independent of both material combinations and tube-sheet thickness.

Test results, Section II, reveal that a considerable amount of tube-sheet distortion comes from mechanical tube-installation steps such as swaging, peening, and rolling. Distortion from welding is in an opposite direction. Total tube-sheet distortion after completion of tube installation is less than that produced by all the mechanical steps or welding alone.

Parts A and B compare distortion from manual welding with that produced by the welding gun. In this case, hand welding gives less tube-sheet deflection. But welding energy input for Part A of 13,800 watt-seconds is significantly less than the energy input of 17,300 watt-seconds for Part B. So there's reason to believe that this spread (about 20%) is largely responsible for the difference in tube-sheet distortion.

Parts C and D compare distortion from manual welding to that produced by machine welding with tubes installed in skip sequence. Here, tube-sheet distortion with machine welding is less, even though the machine process uses a higher welding energy input than the manual welds. The actual difference is about 9%, or less than one-half the corresponding value in Parts A and B.

These results led us to use skip sequence with machine welding for Section III test assemblies.

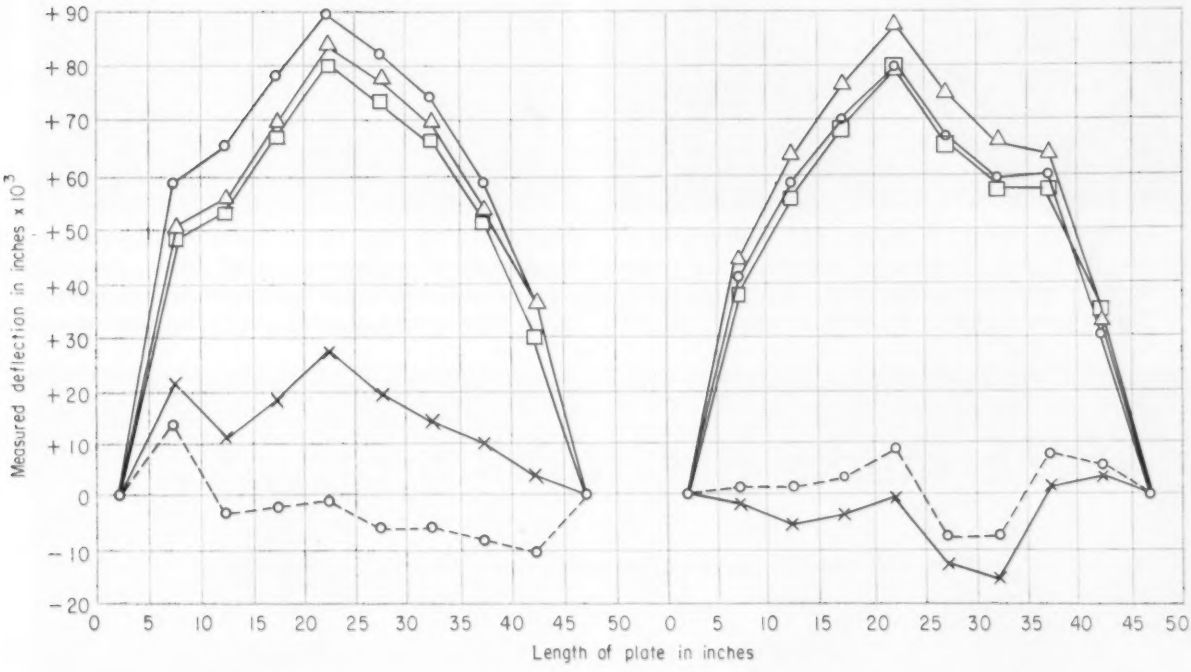
Tube-sheet deflections from peening are relatively small in both positive and negative directions. We can assume they don't have any particular significance.

Tube-joint mechanical strength is tabulated on page 93. Strength of welded joints is given with tubes rolled and not rolled, when pulling tube through the back of the tube sheet. Welded-joint strength with tubes rolled is given when pushing tubes through front of tube sheet.

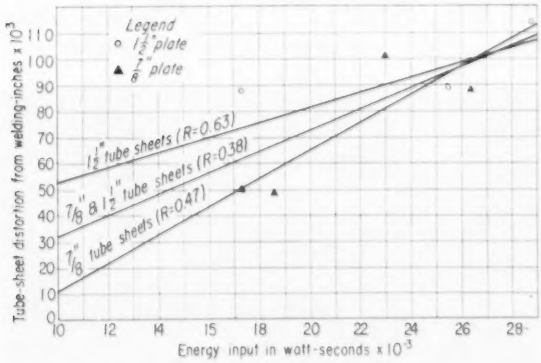
Let's look at joint strength (median values on the basis of specified minimum tensile strength) for tubes pulled and welded only. Manually welded tubes in Parts A and C are weaker than the machine-welded tubes in Parts B and D.

Now compare the strength developed with welded-only tubes to

Weld distortion in all these cases is toward back of the tube sheet



3 Distortion profile for Section IIIC, left, with aluminum-brass tubes has less weld distortion, more mechanical distortion than Section IIIH, right, using admiralty tubes. Both tests used skip-sequence machine welding with 1½-in. naval-brass tube sheets



4 Weld distortion varies directly with energy input. Data is from Sections II and III using machine welding with a skip sequence

Tube-sheet distortion summary for sections II and III

Test	Tube-sheet distortion (in. x 10³)					Total distortion		Energy input per weld (watt-sec)
	Machine	Swaging	Welding	Peening	Rolling	Mechanical	Including welding	
IIA	0	− 3	+ 64.5	− 2.5	−29.5	−35	+29.5	13,800
IIB	0	−28.5	+ 85	− 0.5	−32.5	−61.5	+23.5	17,300
IIC	0	−14.5	+ 63.5	+11	−35.5	−39	+24.5	15,750
IID	0	−45.5	+ 50	+ 2.5	−15	−58	− 8	17,300
IIIA	0	−10	+101	+12	−32	−30	+71	23,000
IIIB	0	−45.5	+ 50	+ 2.5	−15	−58	− 8	17,300
IIIC	0	− 4	+114	−11	− 9	−24	+90	28,800
IIID	0	0	+ 88	− 9.5	+ 1.5	− 8	+80	17,300
IIIE	0	−16	+ 48.5	+ 0.5	−27	−42.5	+ 6	18,600
IIIF	0	−69	+ 88	+16	−22	−75	+13	26,400
IIIG	0	+24	+ 62	− 8.5	+ 3.5	+19	+81	18,500
IIIH	0	− 7	+ 89	− 1	+14	+ 6	+95	25,500

welded and rolled tubes. Rolling seems to contribute to the strength of the weaker joints in Parts A and C. But it hasn't any apparent effect on the higher-strength machine-welded joints of Parts B and D. An exceptionally high strength developed when the tubes were pushed through the front of the tube sheet. This can be attributed to tube deformation under high compressive stress. Tubes expand into tube sheet, develop a high friction force that must also be overcome before welded joints fail.

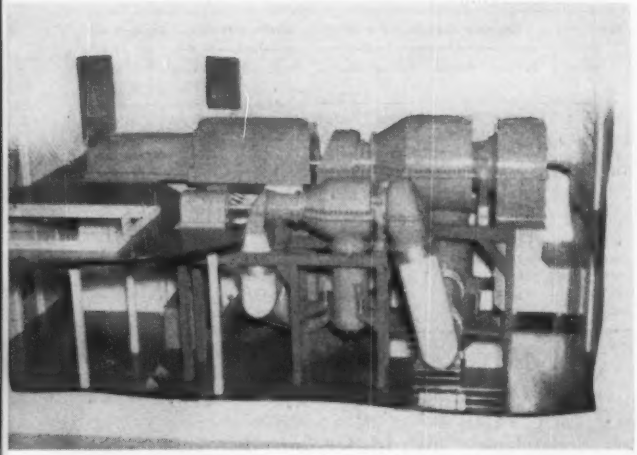
The lower joint strength of manually welded compared to machine-welded tubes is caused by poor weld penetra- (*Continued on page* 194)

Conference sessions drew over 700 engineers to discuss 24 papers covering all aspects of gas-turbine design, application, operation and maintenance. Papers are available at ASME headquarters, NYC

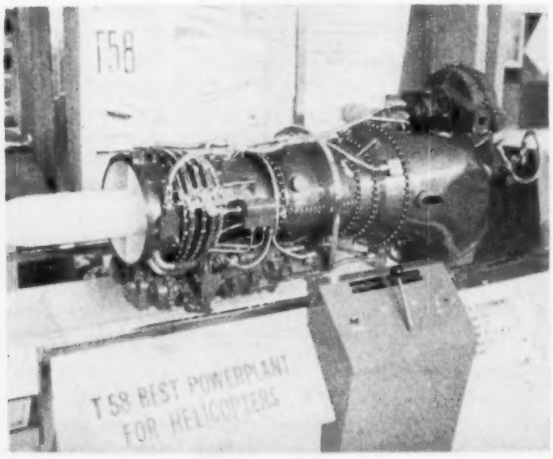
Equipment show had 31 exhibitors giving examples of gas-turbine applications in all fields. Materials suppliers and fabricators featured their contributions to the advancement of many gas-turbine applications

ASME marks gas-turbine progress . . .

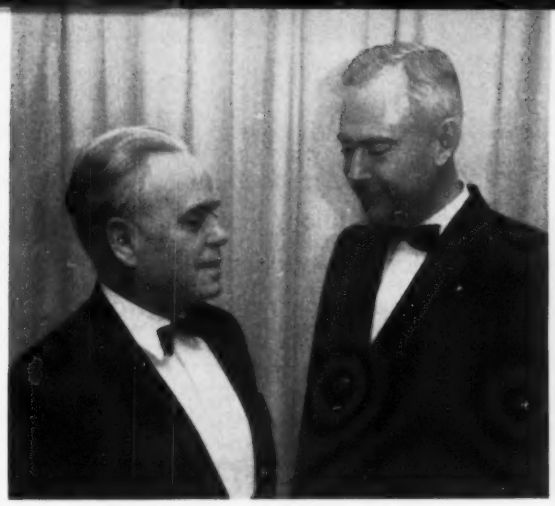
at its 3rd annual gas-turbine conference in Washington, D.C., March 3-6, 1958. Since World War II these versatile units have been finding more and more jobs to do in aircraft, locomotives, ships, stationary power plants and an increasing array of industrial mechanical drives. The conference had nine sessions, an equipment show and outdoor demonstrations of boats, pumps, trucks, electric generators and aircraft service units



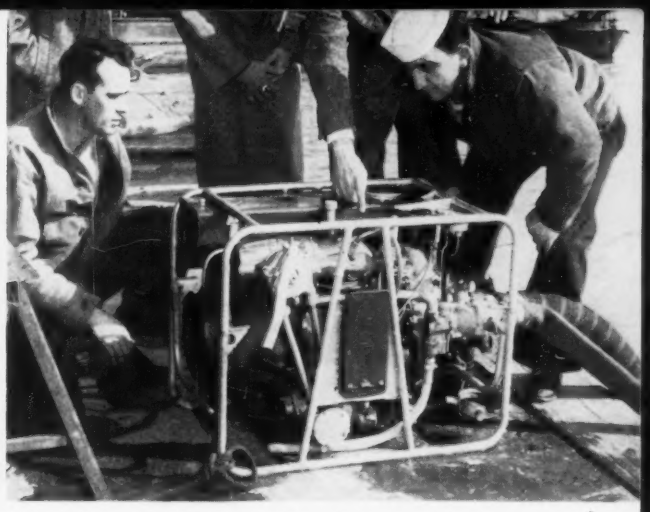
Model of 30-mw 2-shaft unit that's being built by Fiat Co of Italy under Westinghouse license. Unit has 2-stage heating to about 1400 F in single combustors, intercooling, overall pressure ratio of about 15



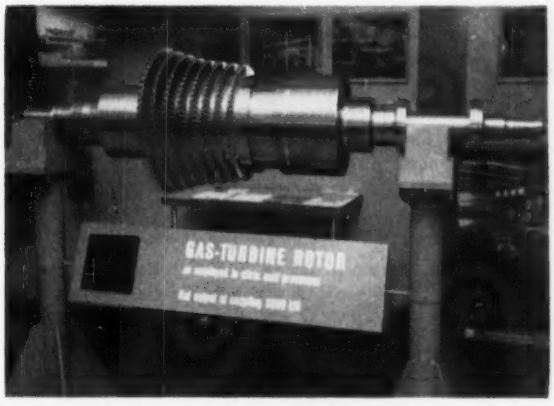
Compact power package develops up to 1050 hp for helicopter drive. The 2-shaft unit is 55 in. long and weighs 267 lb without reduction gear. General Electric Co sees use in boats, oil-well rigs, as turboprop



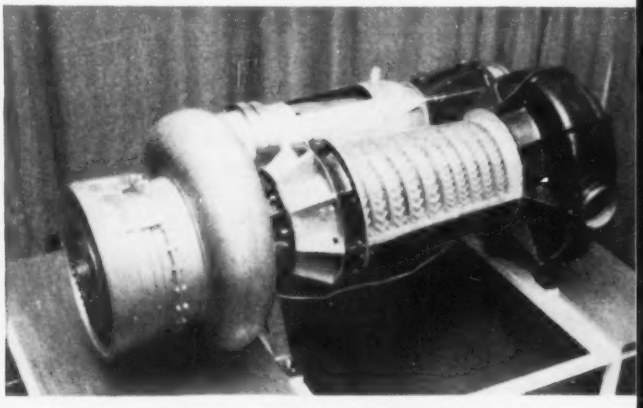
Glenn B Warren, VP of GE Co and director of ASME, gave a talk at the banquet on gas-turbine history and its future. Here he chats with James N Landis, VP of Bechtel Corp and President of the ASME



This 60-hp portable gas turbine drives water pump at 3600 rpm. Gas turbine runs at 46,000 rpm and is hand-started by crank at front left. Utica Div of Curtiss-Wright Corp makes the compact 140-lb unit

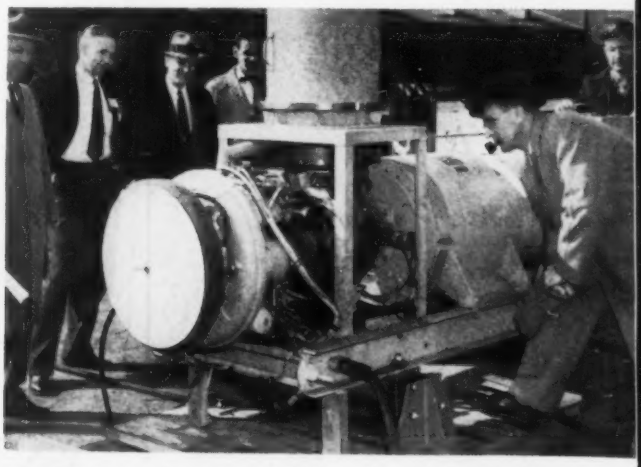


Nitric-acid plants find gas turbines can salvage hot pressurized air to supply part of mechanical power needed in process cycle. This rotor will work in one of 18 turbines built by Brown Boveri of Switzerland

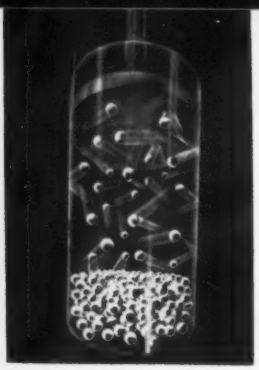


Two-shaft unit develops 500 hp at 20,000 rpm of output shaft at left. A 10-stage compressor feeds single combustor in rear. Solar Aircraft Co also supplies this unit in simpler single-shaft arrangements

Truck developed by General Motors Corp has an experimental 200-hp gas turbine with rotary regenerator to up efficiency. Full-load economy is as good as piston engines, but part-load is considerably lower



Dc generator develops 100 kw for minesweeping service when driven by Boeing Airplane Co's 240-hp 2-shaft gas turbine. Compressor develops overall pressure ratio of 3.6 at a shaft speed of 35,000 rpm



THERMO REFRESHER NO. 18

We continue exploring the major conditions that control the performance of spark-ignited gasoline-burning reciprocating engines. Here's the way compression ratio and water cooling dictate . . .

How i-c engines use thermal energy

By B G A SKROTZKI, Associate Editor

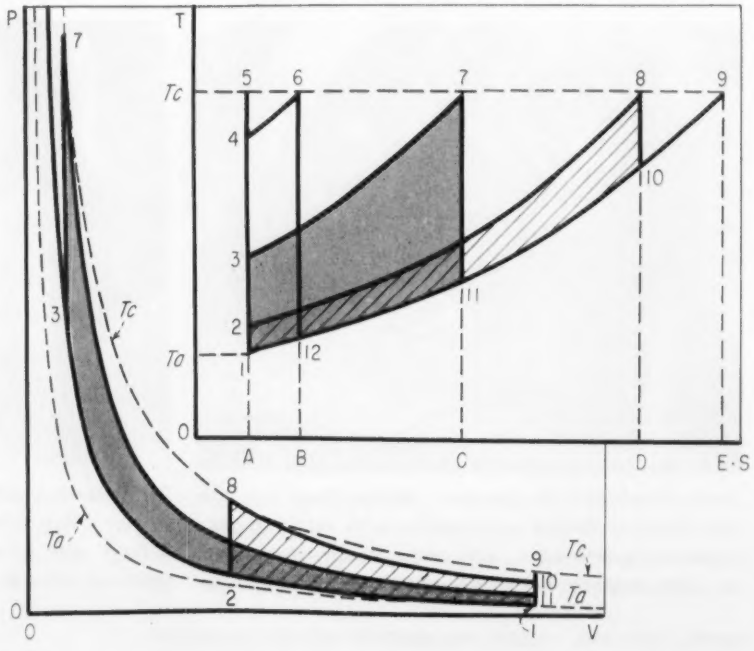
Last month we learned that thermal efficiency of the Otto cycle depends primarily on the compression ratio. Now let's learn how compression ratio affects the work output of the cycle.

Work variation. Fig. 1 shows five cycles running between common top and bottom temperatures, T_c and T_a. The P-V graph shows only three of these because the others run off the top of the graph. As drawn, the cycles have the following ratios:

	Cycle	V_r	T_r	P_r
1.	1-9-9-1	1	4	4
2.	1-2-8-10	2.5	4	10
3.	1-3-7-11	12	4	48
4.	1-4-6-12	60	4	240
5.	1-5-5-1	102	4	408

In the first cycle we get zero work output and thermal efficiency, since this consists of a constant-V heating followed by a constant-V cooling. But let's assume that at *1* we first compress the gas through a minute ratio at constant S, then heat it at constant V to state *9*. At *9* the gas can expand through the minute compression ratio at constant S before cooling it back to *1* at constant V. This would give us net W and Q areas on the graphs thinner than the lines drawn for the process *1-9-9-1*. The point is that the work output and also the thermal efficiency grow from zero as we increase the compression ratio above one.

In the second cycle we get an appreciable growth in work output as the compression ratio rises. The third cycle has the maximum work output of those shown. As we go on to the 4th and 5th cycles we can see the net



1 Five Otto cycles working between same temperature limits but with different compression ratios show that work per cycle grows from zero to a maximum, then diminishes to zero again. Cycle *1-4-6-12* is not shown on P-V chart to avoid confusion of closely spaced process lines

work areas diminishing to zero. The last cycle simply consists of constant-S compression followed by a constant-S expansion.

Just before getting to this last cycle we can visualize that at state 5 we add a minute amount of heat at constant V before expanding the gas at constant S. At state 1 we would remove a minute amount of heat at constant V before recompressing at constant S. Again we have net work area slimmer than the thickness of the line for 1-5.

What happens to the thermal efficiency of these cycles? As we go from the first to the fifth cycles in Fig. 1 the *average* temperature at which we add heat becomes higher and higher. Similarly the *average* temperature at which we reject unusable heat becomes lower and lower. In the first cycle these two average temperatures are equal and since work equals zero the thermal efficiency is zero. In the fifth cycle (with the minute amount of heat added) the average temperatures reach their ultimate limits. So just as the net work vanishes we approach the Carnot thermal efficiency because we are adding heat at maximum possible temperature and rejecting it at lowest possible temperature.

Fig. 2*a* and *b* summarize the variations in heat transfers, compression work, expansion work, net work and thermal efficiency for cycles running between 500 and 3000 °R. As compression ratio rises the heat added Q_A drops quickly at first and then at a decreasing rate. The heat rejected Q_R falls even faster than Q_A and then levels off.

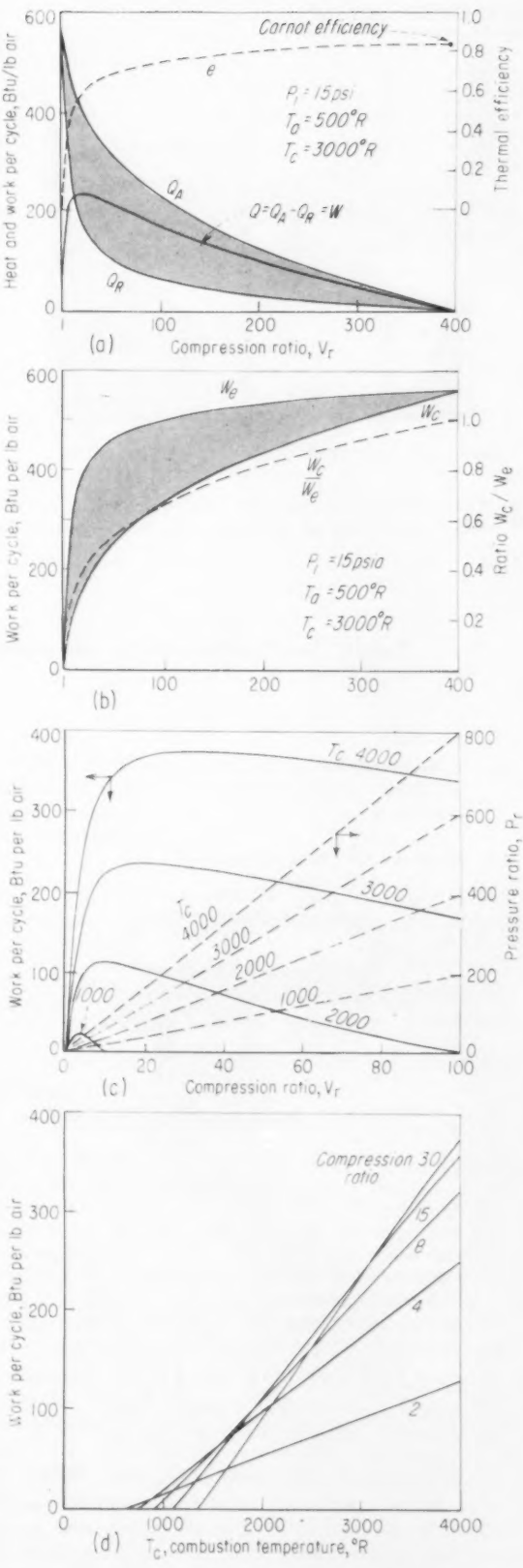
The vertical distance between Q_A and Q_R measures the net heat Q converted to work output W. This rises to a maximum at about a compression ratio of 20. Practical spark-ignition gasoline-fired engines usually run below compression ratios of 10 to avoid pre-ignition and detonation troubles—more about these later.

Thermal efficiency of the cycles rises rapidly to a pressure ratio of 20 as does net W, and then creeps up slowly to the Carnot efficiency just as W drops to zero at the impractically high V_r of almost 400. Here Carnot efficiency = (3000-500)/3000 = 0.833 or 83.3%.

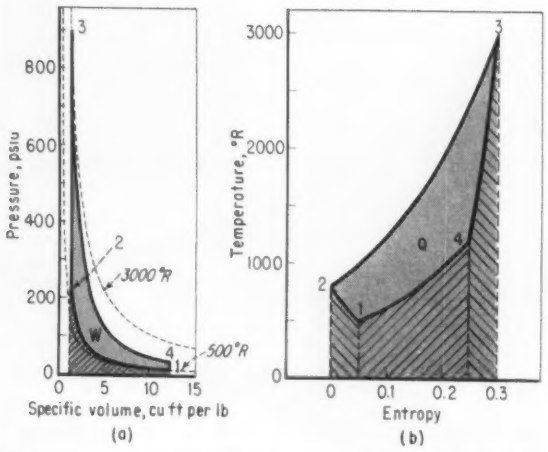
Fig. 2*b* shows the compression work W_c rises steadily at a diminishing rate as compression ratio grows. The expansion work W_e grows even more rapidly than W_c. The vertical difference between them equals the net work output of the cycle, plotted in the graph above. As V_r grows, the compression work absorbs an increasingly larger part of the expansion work W_e.

Fig. 2*c* gives a magnified view of net work variation in the lower range of compression ratio V_r. It also shows how W varies with combustion temperature T_c. As T_c rises the *maximum* W produced occurs at higher V_r. The pressure ratio P_r is proportional directly to temperature T_c and V_r as we learned last month.

Fig 2*d* is simply a crossplot of 2*c* at selected compression ratios. It shows that net work varies linearly with



2 (*a*) Work per cycle peaks at V_r = 20 for given temperatures. (*b*) Expansion and compression works grow with compression ratio. (*c*) Rising heat-input temperatures develop more work per cycle and higher pressure ratios. (*d*) Work per cycle varies directly with combustion temperature, depends on compression ratio



3 Water-cooled or polytropic Otto cycle rejects heat to cylinder water jacket during all processes except for the exhaust *4-1*

difference of combustion and compression temperatures.

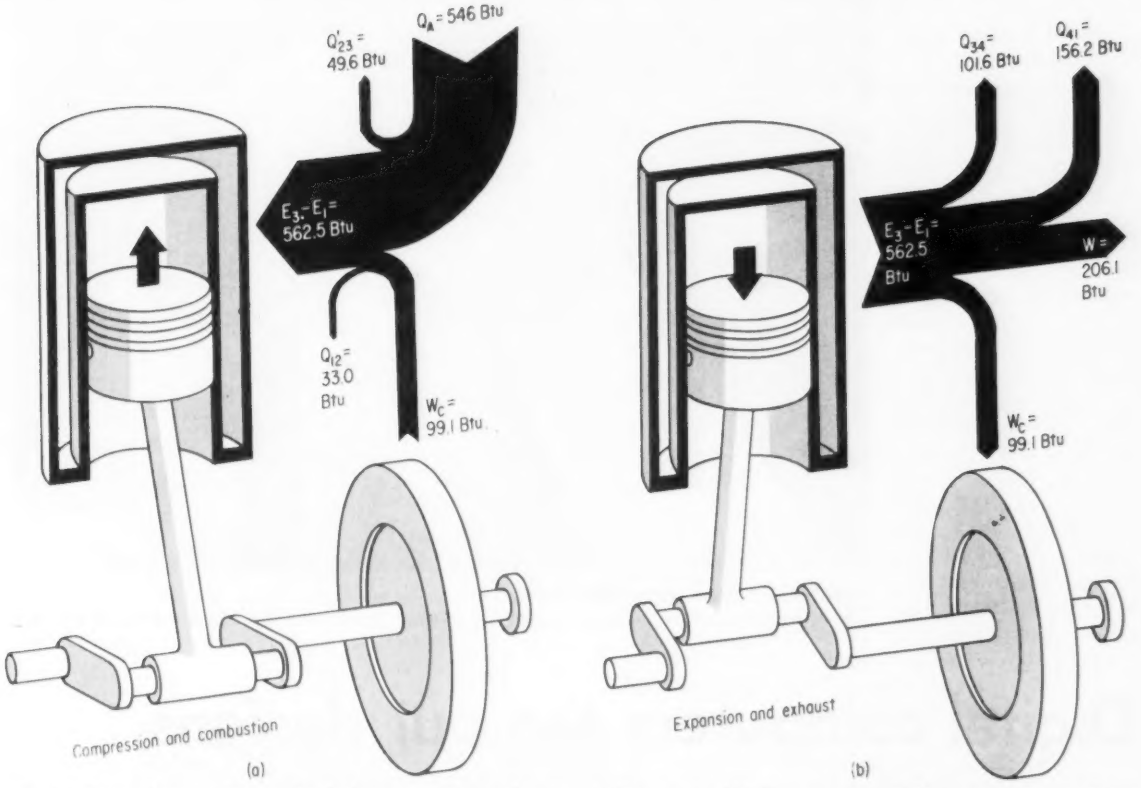
Water-cooled cycle. So far we have been considering an ideal Otto engine with reversible adiabatic expansions and compressions. The cylinder of an actual engine would not be able to live under the punishing combustion temperatures and processes used by the ideal cycle.

To prevent the cylinder from failing (and to preserve the lubricating oil film between cylinder and piston) the cylinder wall is deliberately cooled by a water jacket (or by blowing cooling air over a finned exterior surface). This means that during all processes in the cylinder, the working fluid transfers heat through the cylinder wall. We can study the effect of water cooling by assuming a reversible polytropic cycle as in Fig. 3 and Table 1.

If you really want to understand how the basic equations are applied, get out your slide rule and check the calculations in the table and the graphs. You'll find all the equations explained in Parts 8, 9 and 10, May, June and July 1957 for the individual processes.

Table 1—Performance of water-cooled (polytropic) Otto cycle

1. Cycle specifications; see Fig. 3:
   $T_1 = 500°R$ $P_1 = 15$ psia $V_r = 10$ $c_v = 0.225$
   $T_2 = 3000°R$ $k = 1.3$ Expansion $n = 1.4$
   Compression $n = 1.2$
2. $R = Jc_v(k-1) = 778 \times 0.225(1.3-1) = 52.6$
3. $V_1 = \dfrac{RT_1}{P_1} = \dfrac{52.6 \times 500}{15 \times 144} = 12.18$ cu ft per lb
4. $V_2 = V_1/V_r = 12.18/10 = 1.218$ cu ft per lb
5. $P_2 = P_1\left(\dfrac{V_1}{V_2}\right)^n = 2160 \times 10^{1.2} = 2160 \times 15.86$
   $= 34{,}270$ psfa
6. $T_2 = \dfrac{P_2V_2}{R} = \dfrac{34{,}270 \times 1.218}{52.6} = 793.2°R$
7. $Q_{12} = c_v\dfrac{k-n}{1-n}(T_2-T_1) = 0.225\dfrac{1.3-1.2}{1.0-1.2}(793.2-500)$
   $= -33.0$ Btu per lb
8. $W_{12} = \dfrac{P_2V_2-P_1V_1}{1-n} = \dfrac{34{,}270 \times 1.218 - 2160 \times 12.18}{1.0-1.2}$
   $= -77{,}150$ ft-lb per lb, or
   $-77{,}150/778 = -99.1$ Btu per lb
9. $E_2-E_1 = c_v(T_2-T_1) = 0.225(793.2-500) = 66.0$ Btu per lb
10. Check: $Q_{12}+E_2-E_1 = 33.0+66.0 = 99.0$ Btu per lb $= W_{12}$
11. $Q_{23} = c_v(T_3-T_2) = 0.225(3000-793.2) = 496.4$ Btu per lb
12. Heat transferred to cooling water during process 2-3
    $= Q'_{23} = 0.1\ Q_{23} = 0.1 \times 496.4 = 49.6$ Btu per lb
13. $Q_A = Q_{23}+Q'_{23} = 496.4+49.6 = 546.0$ Btu per lb
14. $P_3 = RT_3/V_3 = 52.6 \times 3000/1.218 = 129{,}600$ psfa
15. $T_4 = T_3\left(\dfrac{V_3}{V_4}\right)^{n-1} = T_3\left(\dfrac{V_2}{V_1}\right)^{n-1} = T_3\left(\dfrac{1}{V_r}\right)^{n-1}$
    $= 3000 \times 0.1^{1.4-1.0} = 3000 \times 0.398 = 1194°R$
16. $P_4 = RT_4/V_4 = 52.6 \times 1194/12.18 = 5156$ psfa
17. $Q_{34} = c_v\dfrac{k-n}{1-n}(T_4-T_3) = 0.225\dfrac{1.3-1.4}{1.0-1.4}(1194-3000)$
    $= -101.6$ Btu per lb
18. $W_{34} = \dfrac{P_4V_4-P_3V_3}{1-n} = \dfrac{5156 \times 12.18 - 129{,}600 \times 1.218}{1.0-1.4}$
    $= 237{,}500$ ft-lb per lb, or
    $237{,}500/778 = 305.2$ Btu per lb
19. $E_3-E_4 = c_v(T_3-T_4) = 0.225(3000-1194)$
    $= 406.3$ Btu per lb
20. Check: $E_3-E_4 = Q_{34}+W_{34} = 101.6+305.2$
    $= 406.8$ Btu per lb
21. $Q_{41} = c_v(T_1-T_4) = 0.225(500-1194) = -156.2$ Btu per lb
22. $Q = Q_{23}-Q_{12}-Q_{34}-Q_{41} = 496.4-33.0-101.6-156.2$
    $= 205.6$ Btu per lb
23. $W = W_{34}-W_{12} = 305.2-99.1 = 206.1$ Btu per lb
24. Heat rejected to cooling water:
    $Q_{cw} = Q_{12}+Q'_{23}+Q_{34} = 33.0+49.6+101.6$
    $= 184.2$ Btu per lb
25. $W = Q = Q_A-Q_{cw}-Q_{41} = 546.0-184.2-156.2$
    $= 205.6$ Btu per lb
26. $e = W/Q_A = 205.6/546.0 = 0.376$ or 37.6%
27. $\text{Mep} = \dfrac{W}{V_D} = \dfrac{W_{34}-W_{12}}{V_1-V_2} = \dfrac{237{,}500-77{,}150}{12.18-1.218} = 14{,}630$ psf,
    or $14{,}630/144 = 101.7$ psi
28. $S_2-S_1 = c_v\dfrac{k-n}{1-n}\log_e\dfrac{T_2}{T_1} = 0.225\dfrac{1.3-1.2}{1.0-1.2}\log_e\dfrac{793.2}{500}$
    $= -0.1125 \times 0.4613 = -0.05188$
29. $S_3-S_2 = c_v\log_e\dfrac{T_3}{T_2} = 0.225\log_e\dfrac{3000}{793.2} = 0.2992$
30. $S_4-S_3 = c_v\dfrac{k-n}{1-n}\log_e\dfrac{T_4}{T_3} = 0.225\dfrac{1.3-1.4}{1.0-1.4}\log_e\dfrac{1194}{3000}$
    $= 0.05625(-0.922) = -0.05185$
31. $S_1-S_4 = c_v\log_e\dfrac{T_1}{T_4} = 0.225\log_e\dfrac{500}{1194} = -0.1959$
32. Check: $S_3-S_2 = (S_2-S_1)+(S_4-S_3)+(S_1-S_4)$
    $0.2992 = 0.05188+0.05185+0.1958 = 0.2996$



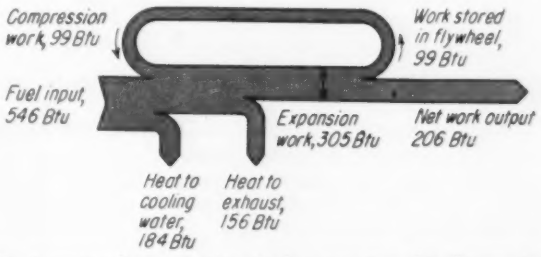
4 (*a*) Energy input to Otto engine during compression and combustion comes from fuel and flywheel with some rejected to cooling water. (*b*) Energy output during expansion and exhaust goes to jacket water, flywheel, exhaust and net mechanical work

The small difference in the check values between equations (8) and (10), (19) and (20), and (32) are due to slide-rule errors. In Fig. 3*b* the hatched area under *1-2* measures the heat transferred to the cooling water during compression at $n = 1.2$; the hatched area under *3-4* measures heat transferred to cooling water during expansion at $n = 1.4$. The hatched area under *4-1* measures the heat rejected with the exhaust gas, at constant V.

Heat rejected during the constant-volume heating *2-3* cannot be shown on the graph and it is figured as a separate estimate in equation (12) in Table 1. The gray area under *2-3* in Fig. 3*b* measures only the heat absorbed by the working fluid and not that simultaneously rejected to the cooling water.

The net areas Q and W are equal, measuring the net work output of the engine, since these are all reversible processes. Equation (26) shows this cycle has a thermal efficiency of 37.6%. In comparison an ideal Otto cycle with constant-S processes and the same $V_r = 10$ and $k = 1.3$ has a theoretical thermal efficiency of 49.8%. To prolong the life of the engine we sacrifice 49.8 – 37.6 = 12.2% in efficiency—not too great a penalty. Actual engine irreversible processes of course make this efficiency penalty even larger.

Fig. 4 summarizes the calculations of Table 1 in energy-flow form. In 4*a*, of the 546 Btu in the fuel (per lb of air), 49.6 Btu is rejected to the cooling water. Of the 99.1 Btu returned by the flywheel to compress the air, 33.0 Btu is rejected to the cooling water. The sum of the remaining energies equals 562.5 Btu, which raises the internal energy of the air in the cylinder during the compression and combustion processes.


Compression work, 99 Btu
Work stored in flywheel, 99 Btu
Fuel input, 546 Btu
Expansion work, 305 Btu
Net work output 206 Btu
Heat to cooling water, 184 Btu
Heat to exhaust, 156 Btu

5 Assuming Otto engine has steady energy flow, this diagram indicates that flywheel-compression energy circulates in engine

In 4*b*, the 562.5 Btu internal energy acquired by the working fluid (combustion products) helps develop the net work output of the engine after satisfying the unavoidable losses. Heat transfer during expansion from the hot working fluid takes 101.6 Btu; the hot exhaust gases take 156.2 Btu with them into the atmosphere. This leaves 305.2 Btu to develop work on the piston during the expansion stroke; (*Continued on page* 194)

ORIGINAL DESIGN REQUIREMENTS, held by author, stimulated digital computer output shown stretched out on table. Results are but some of the satisfactory designs considered

Digital computers tap out designs for large motors...fast

- Digital unit squeezes a man-year into 40 seconds
- Quality goes up, but design costs hold about even
- Accurate performance info can now he had at lower cost
- The educated guess is fast bowing out of motor design

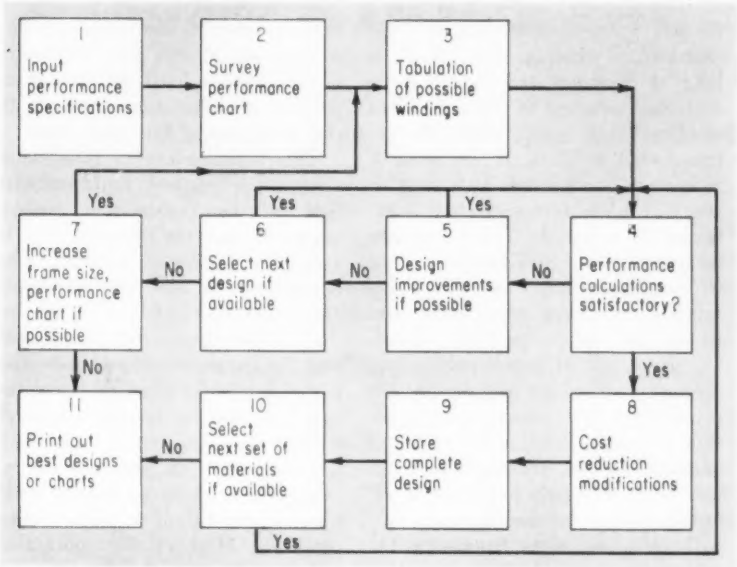
By G L GODWIN, Senior Engineer, Westinghouse Electric Corp

Here at Westinghouse the design of large polyphase induction motors (anything over 200 hp) has been assigned to a high-speed digital computer. Now, this digital computer takes the motor requirements formerly given to a design engineer and, in short order, comes up with a design to meet all guarantees, using standard parts.

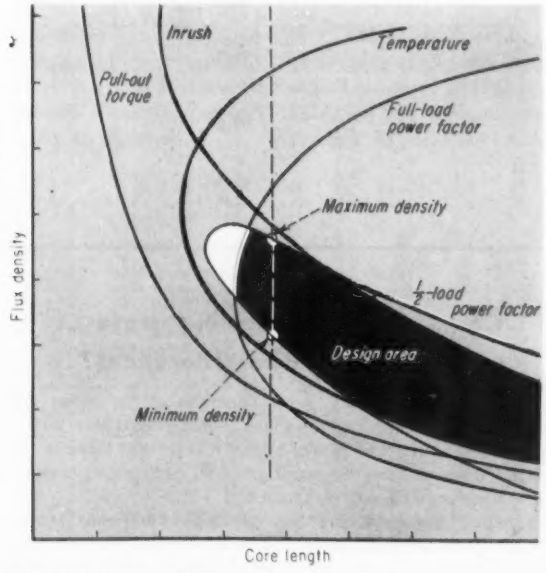
Computer program calls for a complete design, selection of materials and parts, calculation of required performance data. And, when impossible requests are made, computer prints out performance data for the nearest suitable design, giving user best obtainable performance. We look upon this new design routine as the most advanced type of optimizing program, representing a major breakthrough in the application of digital computers to machine design.

Technique used here can be applied to all rotating electrical equipment, while the general method can be applied to almost any form of engineering design (POWER, September 1957, p B.4). Digital program considers all designs that meet customer's specs. From those it selects optimum design, reporting corresponding machine dimensions and performance.

Advantages offered by this technique are many: (1) Every customer's order gets a thorough going over by the computer, to an extent never before possible. (2) Accurate performance data can now be published for a line of machines since both cost and time needed to get this information have been reduced. (3) All special data a customer wants can be supplied immediately after the order has been placed, if it has not already



MOTOR DESIGN FLOWCHART depicts steps in typical operation. Depending on nature and complexity of problem, computer running time may vary from minutes to an hour



PERFORMANCE CURVES form outline-mapping for each guarantee plot relationship between air-gap flux density, machine size

been given during negotiation period.

Design method used for rotating machines is considered by many to be an art rather than science. Wide variation in technique and experience is found among designers, yet the basic procedure is trial and error. In sharp contrast, performance calculations are normally quite accurate with any theoretical gaps filled in by empirical data. Using the computer, design engineer is freed from the tedious mental effort of routine work. He can now concentrate on developing new design methods.

A sound design method is most important, even when modern computers are used. Reason: An induction motor design problem has about 26 variables. If only five values of each are considered, over 10^{18} different designs are possible. So a simple survey, investigating all possible combinations of various parameters, is completely beyond the capacity of existing or contemplated digital computers. Since analytical techniques are not available for machine synthesis, and step-by-step methods do not lead to the required design, a technique has been developed to eliminate quickly the hopelessly unsatisfactory designs. Remainder are surveyed, locating the optimum fast. This calls for a mapping approach to locate the area of satisfactory design. The survey that follows determines detailed designs. To locate the design area, a generalized machine is used with the number of parameters cut to a minimum. Parameters that vary over a narrow range are assigned optimistic values. This mapping is carried out for each guarantee.

Performance curve is really an outline of the mapping for each guarantee. It's a plot of the relationship between air-gap flux density and machine size at the desired level of performance. If guaranteed temperature rise is 40 C, a curve of flux density versus machine size can be drawn in much the same manner that isothermal lines are drawn on a weather map. When a curve representing each guarantee is drawn, an area of satisfactory performance is outlined. The design area has been found, and the minimum machine dimensions can be determined from the chart as a starting point for the attempts at detail design.

Because of extreme complexity of the design problem, computer program assumes right type of materials cannot be determined beforehand; but that optimum designs can be made for each material combination. Then the cost of these designs must be compared for final selection of customer's motor design. A similar situation develops in design of a bridge. Should it be made of wood, steel or concrete? While there are rules of thumb to cover many situations, frequently the final decision can be made only after good designs have been made for each of the competitive materials.

Contour curves are plotted using best performing materials. So small-

est machine will be determined with a minimum number of discrete calculations if initial core length is smallest length included in design area. Once a design has been completed, lower cost materials can be substituted. If modified design proves unsatisfactory, search for a new design can proceed from this point. Since the design area of performance chart drawn for best performing materials includes all poorer performances as well, it is not redrawn for changes in materials.

When impossible requests are made of the computer, 100% efficiency for example, the performance chart becomes the only output. A complete list of performance values is printed out at each critical air-gap flux density so designer will know range of performance values that may be realized. Example: Chart may indicate maximum obtainable efficiency is 96%, so guarantee must not exceed this value if a design is to be gained.

Problem is initiated by reading into computer the performance specs shown on flowchart, top p 103. This is followed by a complete performance chart calculation, Block 2. When performance chart is complete, we go to Block 3 where a study is conducted to develop a table of windings that will provide air-gap flux densities between minimum and maximum density limits. All possible windings are listed in desired order, considering reliability, performance and cost. Calculator proceeds to Block 4 where a complete performance calculation is made on most desirable winding in this table. If performance is satisfactory, we can proceed to Block 8 where an attempt is made to reduce design cost by removing any unnecessary components.

Completed design is stored by Block 9 for later reference; then we go to Block 10. Block 10 selects a new set of materials suitable for this motor, returns calculator to Block 4 to repeat performance calculations for the available new materials. If Block 10 finds no additional materials are available, computer proceeds to Block 11 for printout of best designs. When performance calculations do not meet guarantees, we are transferred to Block 5 where every effort is made to improve the design.

When improvements are on hand, we can return to Block 4; otherwise, we must proceed to Block 6. Here, the next most-wanted winding is selected from winding table. And, as long as windings are available, we are again returned to Block 4. When winding table is exhausted, we are transferred to Block 7. In Block 7, motor size is increased by a suitable step and the performance chart is extended if required. Then computer returns to Block 3 to develop a new winding table, unless new motor size exceeds maximum permissible size. In this case, we can proceed to Block 11. Here, all of completed designs are reviewed and the best designs are printed out for inspection by a design engineer. Printing a number of optional designs provides the engineer with complete freedom for selecting designs for manufacture.

Developing new formulas for performance calculations is not a computer program requirement. However, where improved accuracy is needed, more extensive formulas than those used by today's engineers are employed. All calculations are arranged in subroutines or blocks of relatively small size. Each subroutine performs one definite function. Example: Separate routines are provided for calculation of each of various temperature rises, inrush, pull-out torque, constants that are a function of cross section, etc. Each subroutine is complete in itself and is not dependent on other subroutines in the program, except for input data.

This arrangement of independent subroutines permits rapid substitution of new calculation methods whenever they are required. For instance, remainder of program is not concerned with how machine temperatures are calculated; only the fact that temperatures are provided whenever the temperature routine is called for. Likewise, method of calculating core loss may be revised completely without upsetting rest of program.

All routines in program are arranged in a hierarchy system under ultimate control of a single master program. Most of the subroutines called on directly by the master program have other subroutines at their control. This arrangement of routines may be extended for as many levels as needed to accomplish desired results. In this way, ultimate logic of program is divorced from routines that do calculations. This means that if a new approach to the design program is decided upon at a

(*Continued on page* 190)

Chain grate... traveling grate... do you know the differences?

Both chain and traveling grates operate in the same general fashion. In both, fresh fuel reaches the bed from above and burns progressively as the bed moves to the rear of the furnace. There is no agitation or compression of the fuel bed, which moves *with* the grate surface and not *relative* to it.

It's natural, perhaps, that the terms "chain" and "traveling" are often used interchangeably. Yet, as anyone who has studied stoker construction knows, there are significant differences between chain grates and traveling grates. The chain-grate surface is made up of staggered links interconnected by pins to form a continuous belt or chain the width of the furnace. Traveling grates consist of rows of keys or clips mounted on transverse bars and attached to continuous chains that travel around the supporting frame. The only connection between adjacent transverse rows of keys is through the two or more chains.

All this is called to mind by a letter from Paul W Kluge, President and Treasurer of Laclede Stoker Co. He points out that our December 1957 Modern Plant Survey lists the installation by the Sikeston (Mo.) Board of Public Works as a traveling grate whereas it is actually a chain-grate stoker.—The Editors

Perforated for your filing ease

Power's data sheet

No. 308

Alloy-steel pipe to ASTM Spec A-335 Grade P-1 (½% moly) and ASTM Spec A-335 Grade P-2 (½% CR-½% moly)

Pipe Size In.	Nom. OD In.	Wall Thick In.	Temperature—F: To 750	800	850	875*	900	950	975
			Maximum Allowable Stress—PSI: 13,750	13,450	13,150	12,825	12,500	10,000	8,125
Schedule 10									
14	14	.250	303	296	289	285	278	222	181
16	16	.250	267	261	250	249	243	194	158
18	18	.250	234	228	223	221	215	172	140
20	20	.250	213	208	204	199	194	155	126
24	24	.250	178	175	171	162	163	130	106
Schedule 20									
8	8.625	.250	495	484	473	464	453	363	296
10	10.75	.250	399	390	381	372	363	290	237
12	12.75	.250	336	328	321	313	305	245	199
14	14	.312	413	404	394	386	376	302	246
16	16	.312	357	350	342	337	329	264	215
18	18	.312	316	309	302	299	291	234	190
20	20	.375	371	363	355	337	333	267	217
24	24	.375	303	296	289	283	276	220	180
Schedule 30									
8	8.625	.277	577	565	552	535	521	420	342
10	10.75	.307	529	518	506	494	481	386	315
12	12.75	.330	495	484	473	457	445	357	291
14	14	.375	522	511	500	489	476	382	312
16	16	.375	454	444	434	427	416	334	272
18	18	.438	495	484	473	458	446	358	292
20	20	.500	522	511	500	486	474	380	310
24	24	.562	495	484	473	463	451	362	295
Schedule 40									
½	.840	.109	1554	1520	1486	1448	1411	1142	939
¾	1.05	.113	1334	1304	1275	1240	1209	976	801
1	1.315	.133	1443	1412	1380	1341	1308	1057	868
1¼	1.66	.14	976	955	933	905	883	710	582
1½	1.90	.145	921	901	881	859	838	675	552
2	2.375	.154	825	807	789	775	755	608	497
2½	2.875	.203	1114	1089	1065	1040	1014	818	670
3	3.50	.216	1004	982	960	935	911	734	601
4	4.50	.237	894	874	855	831	810	652	533
5	5.563	.258	811	794	775	761	741	597	488
6	6.625	.28	763	746	730	712	694	558	456
8	8.625	.322	707	686	671	659	643	517	422
10	10.75	.365	660	646	631	618	603	484	395
12	12.75	.406	633	618	605	594	579	465	380
14	14	.438	633	618	605	591	576	463	378
16	16	.50	653	639	625	609	594	477	390
18	18	.562	666	646	631	621	605	486	397
20	20	.593	633	618	605	593	578	464	379
24	24	.687	626	612	598	584	569	457	373
Schedule 60									
8	8.625	.406	949	928	908	886	864	696	569
10	10.75	.50	982	955	939	916	893	719	589
12	12.75	.562	949	928	908	882	860	693	567
14	14	.593	921	901	881	854	833	670	548
16	16	.656	894	874	855	837	816	657	538
18	18	.750	927	907	881	864	843	679	555
20	20	.812	908	888	867	849	828	666	545
24	24	.968	921	901	881	858	836	704	576
Schedule 80									
½	.84	.147	2783	2717	2662	2596	2530	2066	1714
¾	1.05	.154	2378	2326	2275	2214	2158	1756	1453
1	1.315	.179	2394	2342	2289	2233	2176	1772	1466
1¼	1.66	.191	1773	1735	1696	1658	1616	1310	1078
1½	1.90	.20	1669	1633	1596	1557	1518	1229	1011
2	2.375	.218	1526	1493	1460	1421	1385	1120	921
2½	2.875	.276	1781	1742	1703	1661	1619	1312	1080
3	3.50	.30	1622	1587	1551	1512	1474	1193	981
4	4.50	.337	1471	1439	1407	1367	1333	1077	885
5	5.563	.375	1348	1318	1288	1261	1229	993	815
6	6.625	.432	1348	1318	1288	1259	1228	992	814
8	8.625	.50	1232	1205	1178	1149	1120	904	741
10	10.75	.593	1202	1176	1144	1121	1093	882	723
12	12.75	.687	1196	1170	1144	1116	1088	878	719
14	14	.75	1202	1176	1144	1121	1093	882	723
16	16	.843	1196	1170	1144	1117	1089	879	720
18	18	.937	1196	1170	1144	1113	1085	876	718
20	20	1.031	1196	1170	1144	1111	1083	874	716
24	24	1.218	1182	1156	1130	1107	1079	871	714

Pipe Size In.	Nom. OD In.	Wall Thick In.	Temperature—F: To 750	800	850	875*	900	950	975
			Maximum Allowable Stress—PSI: 13,750	13,450	13,150	12,825	12,500	10,000	8,125
Schedule 100									
8	8.625	.593	1512	1479	1446	1409	1374	1111	913
10	10.75	.718	1499	1466	1433	1402	1366	1105	908
12	12.75	.843	1512	1479	1446	1413	1378	1114	916
14	14	.937	1554	1520	1486	1445	1409	1140	937
16	16	1.031	1499	1466	1433	1400	1365	1104	907
18	18	1.156	1512	1479	1446	1408	1373	1110	912
20	20	1.281	1512	1479	1446	1415	1379	1115	916
24	24	1.531	1526	1493	1460	1424	1388	1122	922
XX									
½	.84	.294	8454	8269	8085	7835	7685	6551	5696
¾	1.05	.308	6904	6753	6603	6439	6276	5287	4535
1	1.315	.358	6545	6402	6259	6105	5950	4998	4275
1¼	1.66	.382	5115	5003	4892	4771	4650	3864	3265
1½	1.90	.400	4689	4586	4484	4373	4263	3530	2973
2	2.375	.436	4111	4022	3932	3835	3738	3082	2584
2½	2.875	.552	4524	4425	4326	4219	4113	3402	2861
3	3.50	.600	4043	3954	3866	3771	3675	3029	2538
4	4.50	.674	3534	3457	3380	3296	3213	2633	2201
5	5.563	.750	3190	3120	3051	2975	2900	2375	1977
6	6.625	.864	3135	3067	2998	2924	2850	2333	1941
8	8.625	.875	2391	2339	2287	2230	2263	1770	1464
Schedule 120									
4	4.50	.438	2048	2004	1959	1915	1866	1516	1250
5	5.563	.50	1952	1910	1867	1817	1771	1437	1185
6	6.625	.562	1870	1829	1788	1743	1699	1378	1135
8	8.625	.718	1397	1856	1815	1766	1721	1396	1150
10	10.75	.843	1815	1775	1736	1690	1648	1336	1100
12	12.75	1.00	1842	1802	1762	1717	1674	1357	1118
14	14	1.093	1842	1802	1762	1720	1676	1359	1120
16	16	1.218	1815	1775	1736	1689	1646	1335	1099
18	18	1.375	1829	1789	1749	1708	1665	1350	1112
20	20	1.50	1801	1762	1722	1683	1640	1329	1095
24	24	1.812	1336	1796	1756	1712	1669	1353	1114
Schedule 140									
8	8.625	.812	2186	2139	2090	2040	1989	1617	1335
10	10.75	1.00	2206	2152	2104	2057	2005	1630	1346
12	12.75	1.125	2104	2058	2011	1962	1913	1554	1282
14	14	1.25	2145	2098	2051	2003	1953	1587	1310
16	16	1.437	2172	2125	2078	2031	1980	1610	1329
18	18	1.562	2117	2071	2025	1970	1920	1560	1288
20	20	1.75	2145	2098	2051	1997	1946	1582	1306
24	24	2.062	2117	2071	2025	1972	1923	1562	1289
Schedule 160									
½	.84	.187	4166	4075	3984	3890	3791	3128	2623
¾	1.05	.218	4125	4035	3945	3850	3753	3095	2595
1	1.315	.25	3938	3852	3766	3673	3580	2948	2468
1¼	1.66	.25	2756	2690	2630	2570	2505	2045	1696
1½	1.9	.281	2832	2770	2709	2646	2579	2106	1748
2	2.375	.343	2956	2891	2827	2757	2688	2197	1825
2½	2.875	.375	2714	2655	2596	2532	2468	2014	1670
3	3.50	.438	2685	2627	2568	2505	2441	1992	1651
4	4.50	.531	2632	2569	2517	2455	2393	1951	1617
5	5.563	.625	2557	2501	2445	2388	2328	1897	1571
6	6.625	.718	2507	2448	2393	2338	2279	1857	1537
8	8.625	.906	2489	2434	2380	2321	2174	1843	1526
10	10.75	1.125	2523	2468	2413	2353	2294	1869	1543
12	12.75	1.312	2502	2448	2393	2338	2279	1857	1537
14	14	1.406	2447	2394	2340	2287	2229	1815	1502
16	16	1.593	2447	2394	2340	2282	2224	1811	1499
18	18	1.781	2447	2394	2340	2279	2221	1809	1497
20	20	1.968	2441	2387	2334	2276	2219	1807	1495
24	24	2.343	2434	2380	2328	2271	2214	1803	1492

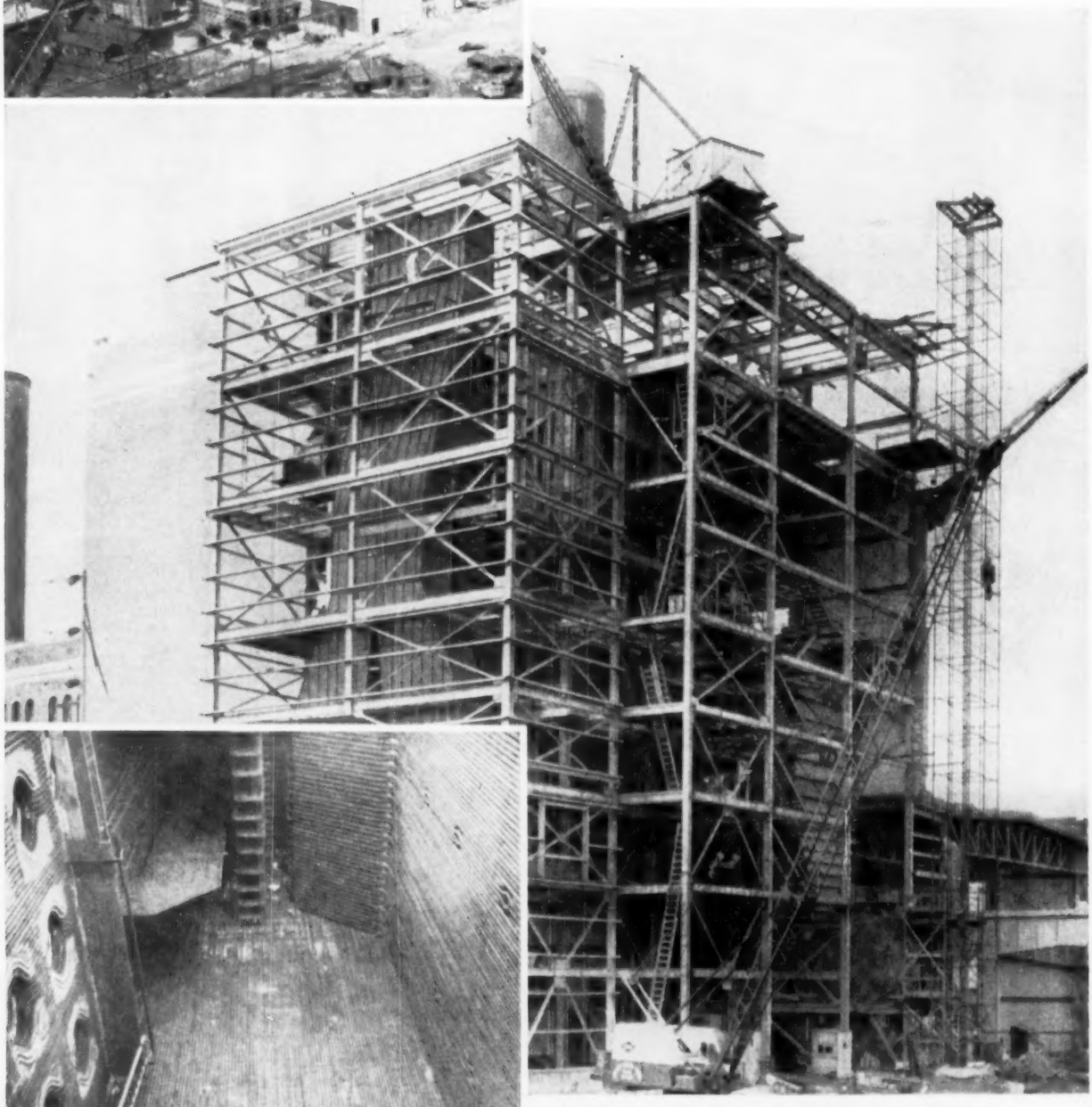
Maximum allowable working pressure—3

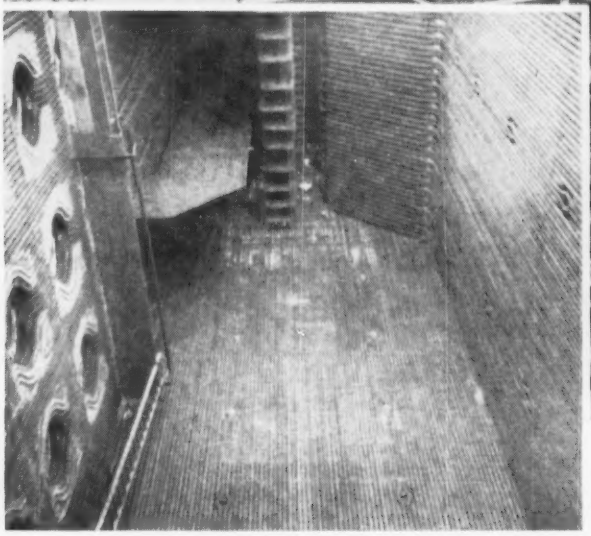
Figures in this table give the maximum psi pressures for given temperatures and stresses. Don't exceed 875 F for P-1 and 975 F for P-2. See February *Data Sheet 306* for the basic formula from which this table was calculated.

GEORGE C HALZELL, *Boston, Mass.*

© POWER

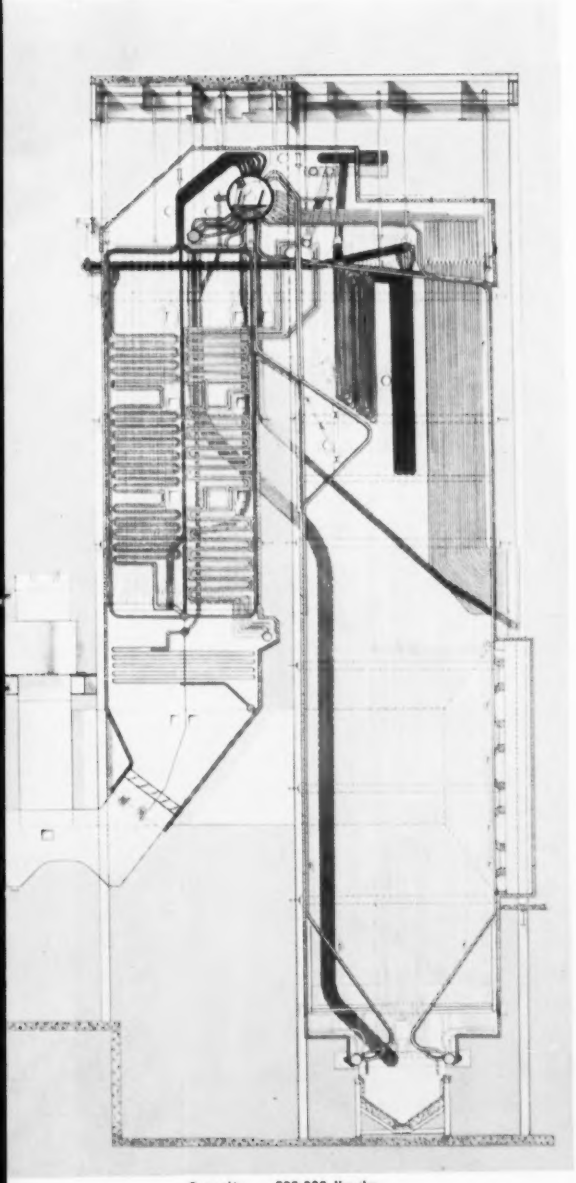
This is R. S. Wallace Station showing modern enclosure for Unit No. 6, a 600,000 lbs./hr. Riley Boiler. Below, Unit No. 7 under construction.





Inside furnace of Unit #7 at E. Peoria. At left — 5 of 16 Riley Flare Type Burners; burner openings are water-cooled. Top left — one of two bare tube platens that are employed to evenly distribute furnace heat across superheater and reheater.

Sixth RILEY Boiler at R. S. Wallace Station



Capacity — 690,000 lbs/hr.
Drum pressure — 1650 psig
Superheat, Reheat — 1000 F
Fuel: Central Illinois Coal
Average Overall Efficiency — 87.7%
COMMONWEALTH ASSOCIATES, INC.
CONSULTING ENGINEERS

CENTRAL ILLINOIS LIGHT COMPANY has also ordered its EIGHTH Riley Boiler for its Lamarsh Station

Since 1939, Central Illinois Light Company has installed six Riley Boilers in its East Peoria R. S. Wallace Station. The latest, a 690,000 lb/hr Reheat Unit is illustrated here and will shortly go on the line. The recent order of an 850,000 lb/hr Reheat Unit for Lamarsh Station will bring the total of steam generated by Riley boilers to 3,415,000 lbs/hr. Dependable operation, and high availability are the operating characteristics of these Riley boilers.

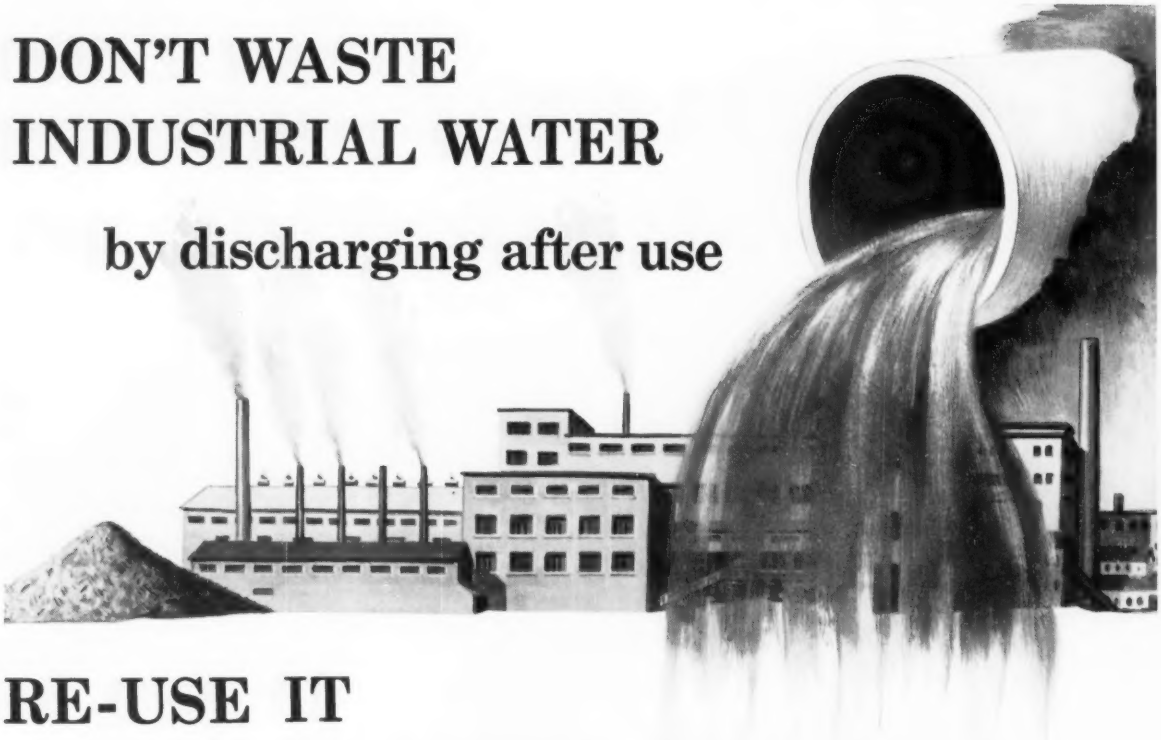
A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs. .

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

DON'T WASTE INDUSTRIAL WATER

by discharging after use



RE-USE IT

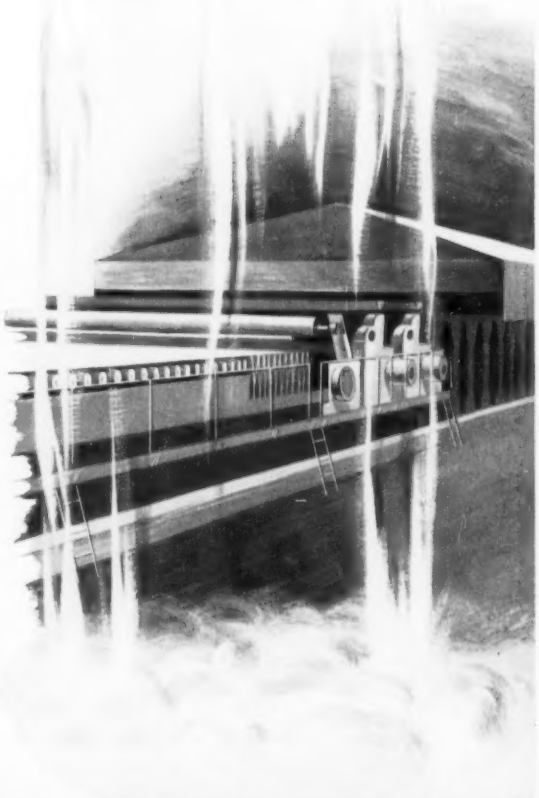
by clarifying with Celite filtration

Recycling your process water instead of discharging it makes good sense in four important ways:

1. It cuts your water costs.
2. It conserves your community's water supply.
3. It helps you meet the high sanitation standards now imposed in many areas.
4. It protects your local rivers and streams from pollution . . . preserves these waterways for recreational purposes.

It also makes good sense to use Celite* diatomite for clarifying this plant waste. Celite filtration removes more suspended solids, including amoebae, algae and most bacteria. It operates at fast flow rates with any conventional pressure filter. It comes in 9 standard grades for precise clarity control. And it is low in cost.

A Celite engineer will be glad to study your water problem and offer recommendations with no obligation. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.



*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products

JM Johns-Manville CELITE diatomite filter aids

Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge

It may be calm today and like this tomorrow. So plan now since . . .

You can hold flood damage in line

Your plant may be hit by floods this spring. If so, your job as a plant-service engineer means you'll be handling two major assignments: *dealing with people, and dealing with equipment.* But, the real big step comes right *now* in planning and organizing for the day the flood strikes.

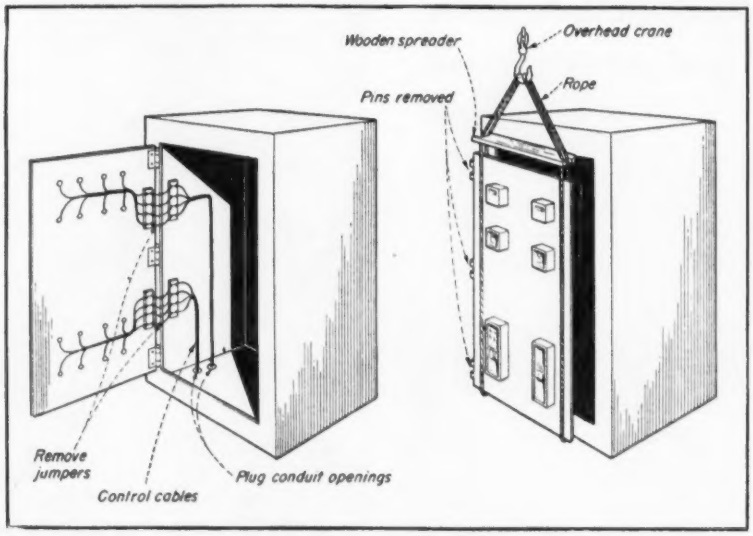
On the people's side of the picture, keep in mind that floods create mental stress. You, like the next man, will be hammered by personal anxieties. Concern about your family will hamper your effectiveness in the plant. But, you can keep this portion of your potential trouble in line by anticipating protective measures for the family and house, now.

First step in dealing with people on the job and under stress is to know yourself. Getting a true picture of your own weaknesses goes a long way when trying to cope with weakness in others. Probably the critical item in the check list of knowing your own shortcomings is to set a realistic target on the limit of your capabilities. Don't go beyond this point or you'll wind up in the same shape as those who need your help.

Prepare for some pretty basic reactions by your crew. Individual panic, depression, overactivity and out-and-out physical disability will probably crop up. Hope that a sizable portion of your men hold a pretty normal straight-line balance. It's your responsibility to show true leadership and a calm approach.

Look even further ahead. When flood waters recede you'll face a heart-breaking mess. You will be tired and somewhat rattled, but you'll only be reaching another plateau. Your thoughts will turn to new problems: How much can be saved . . . who to assign to what job . . . where to start?

Tear out and file this 7-page article



REMOVE PANELS from cubicle-type control equipment before flood water hits. This step will save on meter overhauls later. Use portable electric heaters to dry wiring

Choose equipment carefully for storage out of water's reach:

Pick key men for the key jobs . . . beforehand

Everyone suffers from the it-won't-happen-to-me attitude. This is especially dangerous when dealing with possible plant disasters. Best bet is to assume it *will* happen to me. Then go about organizing a practical plan to follow before, during and after the emergency. Pick your men carefully for key positions, select equipment beforehand for key attention.

Check insurance coverage with the experts. As in all forms of insurance (except life), management must decide how much to spend for protection that may never be needed. Insurance policies, supplies and disaster equipment are costly.

Remember that rising waters from heavy late winter snows, or summer and fall hurricanes, are not the only flood causes you have to worry about. Broken water mains and flash rainstorms can rack up a heavy toll. You won't be able to avoid all trouble, but advance planning sure helps.

During the first of the hurricane-caused floods, a Connecticut firm kept a running log. And they made a complete day-to-day record of recovery activities after the flood. They analyzed these records, drew up a disaster plan. When the second flood hit, the plan of attack helped minimize the damage. This plant learned two important facts: (1) When fighting flood, protect equipment needed for rescue, recovery and emergency repair after water recedes. (2) Don't waste time on areas or equipment you can't save.

Repair gear takes on more value during crises than in normal times. Saving several lathes, instead of a gasoline winch or crane, may add days to your recovery time. Make up a list now of practical recovery items to simplify emergency operations later. A few words about the second fact: It's better to save some equipment and lose some than to spread yourself too thin and lose everything. This can be a painful decision, but it must be made.

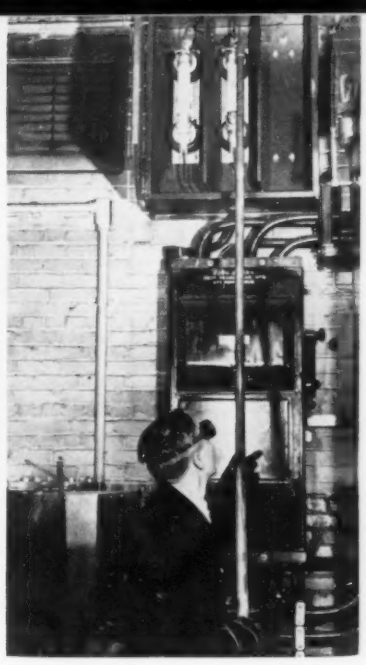
Keep your men thinking about disaster all year. Point out the need for planning a course of action. Get their suggestions on weak spots. You'll find that teamwork pays off.

Emergency equipment. When floods come everyone needs supplies. Don't be caught flat-footed. Keep pieces of tarpaulin, infrared bulbs, burlap bags, sand, cinders, shovels, batt insulation, woven chicken wire, lumber, coal, rope, boats and stone on hand. Buy as many gasoline-engine-driven pumps as you need or can afford, or arrange beforehand to rent them. Manpower is important, more so if you can't find any. So, play safe and line up help from plants not faced with immediate danger. Don't depend on help from a plant in the same predicament.

How about spare parts and emergency equipment? Store them high and dry, ready for instant use. If air-driven pumps are available, provide some means for heating the air supply to prevent the air motor from freezing in cold weather.

General protection. First thing to do is to hold the water outside the plant as long as possible. This means closing all vulnerable openings—doors, pipe trenches, drains, ventilating holes and windows—with steel or heavy timber bulkheads. Don't depend on ordinary doors or windows

SOCKET METERS are easily removed from instrument panels beforehand. Cushion them with excelsior or rumpled paper, move to a safe place. Wiring can be reused after drying



PULL SWITCHES before leaving plant. And don't depend on utility lines being dead

Start with engine-driven pumps and portable electric generators

to withstand any appreciable amount of water pressure.

Timber dikes, backed up by sand bags or heavy stone and sealed with cinders, serve as first-line defense against water entering a building. But, before erecting permanent concrete enclosures around a structure, check with the design engineer and architect as to the safe height. Water seepage under the building may exert dangerous uplift pressure if retaining wall is too high.

Lower elevations. Inside the plant, close off all floor drains if water can back up from outside. Flap valves on the outside of such pipes offer good protection if they seat tightly. Remove all motors and electrical equipment that can be spared and install an emergency-station sump pump when and if the regulars get flooded. If there is any danger of surface condensers being submerged, fill the condensate side with water to prevent uplift. Be sure to block up the footing springs, as they are not designed to support the condenser when completely water filled.

If possible, empty oil-storage tanks into tanks on a higher elevation, then fill with water. An air-filled tank, broken loose and floating, can raise hob with other equipment. Also, overflow oil will coat everything as water level changes. Remove as much oil as possible, as soon as it appears.

Boilers. Method of firing calls the shots on necessary precautions. When boilers are flooded, count on less damage if they have been cooled beforehand. Leave the watertubes full for the additional weight. With a pulverized-coal system, remove at least one pulverizer to a safe area. Do the same for stoker and oil-pump motors.

If generators are in danger, take them off line and allow to cool. Do the same for any large motors. Insulation will absorb far less moisture if cool before water hits.

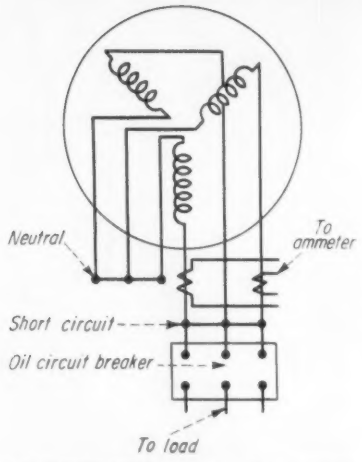
To recondition, first clean exteriors—walls, pipes, machinery—thoroughly. Then provide for building heating to prevent further damage and to dry the atmosphere.

Select cleaning solutions carefully. They may do more harm than good if not used carefully. Carbon tetrachloride, while not flammable, attacks certain insulations. Test it on a sample. Also, it can be fatal if inhaled in quantity. Provide masks and good ventilation for all volatile solvents.

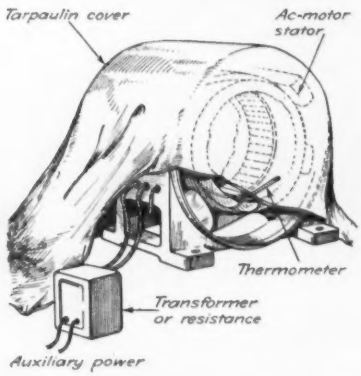
Heat sources. Generators or welding machines, driven by gasoline engines, supply current for internal heating. Ovens, salamanders, infrared lamps, oil stoves and wood fires provide external heating. If you don't have and can't construct a temporary oven out of sheathing, boards or other material, throw a tarp over the equipment and direct a stream of hot air over the material. If things get too hot, insulation may melt, char, even burn. Also, if too much heat is applied, steam might form and ruin insulation. Whether oven is rigid or not, provide vent holes for vapor to escape.

Insulation resistance. Only sure way to tell when equipment is dry enough for operation is to check it with a megohmmeter. Minimum safe value is important. Some insurance companies and most plant electrical engineers require 1 megohm per 1000 volts with a minimum of one megohm for all machines below 1000 volts.

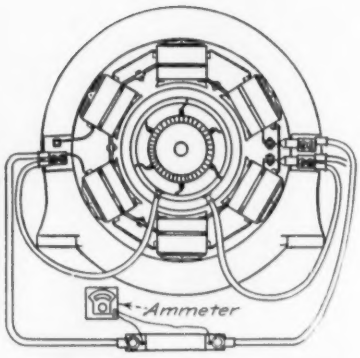
It's easy to puncture wet insulation. So dry wet machines to some degree before using megohmmeter. Low output voltage can be had by turning crank slowly. You will still get some



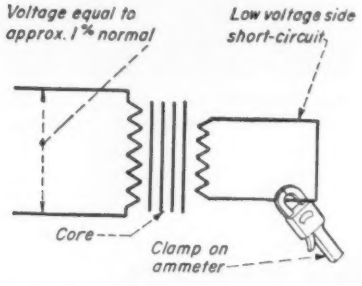
AC GENERATOR can be short-circuited with a ct and ammeter in the closed circuit



WATCH VENTING. Complete covering holds heat effectively but traps moisture



TO DRY DC machines, short-circuit armature, reverse series field, weaken shunt field



TRANSFORMER HEAT calls for shorting out one winding, keeping check on amp

Keep maximum temperature in check when drying

The drying practice for electrical gear is mighty important. On some equipment you can get away with simple external heat. But on motors, generators, transformers, etc, you should use both internal and external heat. Apply heat slowly; don't try to rush the job. Build from ambient to 80-95C. With small equipment, the job can be done in a matter of hours. Ten days to two weeks is often needed to completely dry large units.

Whether lamps, stoves, ovens or amperes flowing within windings supply the heat, watch ventilation. If not vented, steam produced can cause real trouble. As sketches show, internal heating is handled by short-circuiting generator or transformer leads, holding voltage down to keep out of trouble. Outside source of low-voltage power does the trick for motors.

After flood, break the job into two parts—what you can handle and what to farm out

indication of insulation resistance at these low voltages.

Check against past records to determine when a machine can be put back into service. To get greater accuracy when measuring resistance: (1) Ground windings momentarily before each test to remove static. (2) Suspend megohmmeter leads by cord or tape—don't let them lie on ground or frame. (3) Always use lead marked ground on the machine frame. (4) Turn crank for exactly one minute before reading. (5) Take each reading at same machine temperature.

Take readings about every two hours at first, every four hours later. Plot a curve to show the progress of the drying-out operation.

Moisture, dirt, and then temperature have the greatest effect on insulation. So, duplicate operating temperature, if possible, when taking readings.

Following suggestions for specific equipment are handy before and after flood water hits. Methods outlined for drying insulation helps when planning a reconditioning program. Don't consider the given temperatures safe in all cases. *Use a temperature that is proven safe for each type insulation.*

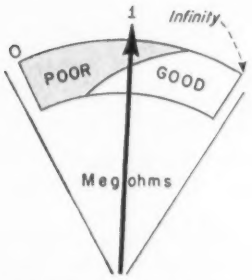
Transformers, oil-filled and fitted with an oil expansion tank, can be protected. Start by lowering oil level to slightly below transformer top, disconnect conservator tank and put blind flange on opening. Use a good gasket. Pack ordinary roofing compound around flange connections (cover plate, bushing flanges, explosion relief). Final precaution: lash outdoor units to foundations to prevent wave action from pushing them over.

For medium-sized oil-filled units with no expansion tank, replace cover-plate breather with ordinary pipe plug. Again, use roofing compound. If possible, move small transformers out of harm's way.

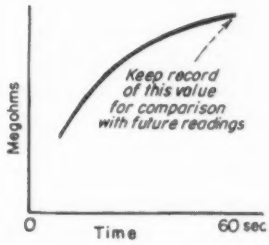
To clean, first hose down the outside. Open bottom oil drain and remove any water. If none appears, give high pot test to top and bottom oil samples. If they test 22 kv or more, check resistance of primary and secondary windings. Before restoring to service, give unit a 10% overvoltage test.

Oil must be cleaned and dried if water entered transformer. While doing this, wash windings and inside of case with clean oil. Blow air preheated to 85-95C through bottom drain valve or insert air duct through

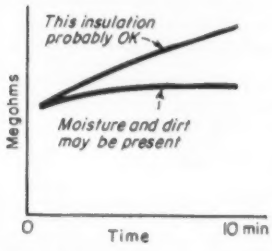
When checking insulation resistance, big job is to interpret results properly



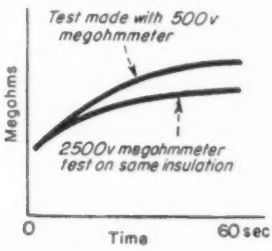
ONE MEGOHM per 1000 v is still a sound yardstick for good insulation resistance



SHORT-TIME TEST calls for hooking up megohmmeter, cranking for about 60 sec



DIELECTRIC ABSORPTION requires taking two readings after set time intervals



TWO-VOLTAGE technique takes advantage of results obtained with varying potentials

There are three practical methods for measuring resistance of electrical insulation with a megohmmeter: (1) short-time or spot reading (2) dielectric absorption or time resistance (3) two-voltage.

Spot-reading means simply connecting the megohmmeter across the insulation to be tested and operating the instrument for a short time. For a fast, routine check this method is OK. Using a dielectric absorption, an almost steady value is arrived at shortly after test voltage is applied when winding is wet or dirty. Insulation resistance of a dry winding in good condition may continue to increase for hours. With hand-cranked megohmmeters, run the test for 60 sec, taking readings at 30- and 60-sec points. As a rule of thumb, when the 60:30 sec ratio is below 1.25, insulation's condition is questionable.

Note from sketch, *lower left*, that insulation resistance usually drops as test voltage is materially increased. But, for a variation of 2 or 3:1, in the usual test-voltage range, there's no appreciable change in resistance *for insulation in good condition*. For more info see POWER, June 1950, pp 116-117.

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manhole. Allow air to vent through top manhole. Short-circuit current may be used to supplement hot air.

If only a small trace of water seeped into unit, heat winding without draining oil. Short-circuit one winding, apply less than normal voltage to other. Aim for 85-90C winding temperature for shell type, 75-80C for core type. Immersion heaters will also prove helpful.

If circulating-current method is used, deenergize unit every two hours and check resistance. Also circulate oil. Unit is OK when winding resistance equals 1 megohm for every 1000 volts operating voltage. Again use 10% overvoltage test before returning to service.

Do not expose windings to outside air. They will absorb moisture quickly. Pump good oil back into transformer as soon as coils dry.

Circuit breakers. Drain and store oil in dry, clean barrels. Cover wooden connecting rod on movable contacts with grease and wrap with cloth. Remove operating and trip coils on motors and tank liners. Dismantle all units that can be spared to get replacement parts.

To recondition, wash breaker with hose. Dismantle, clean and dry everything. Dry coils by passing current through and hot air over windings, or put in oven. Check for warping, binding of parts.

Air-circuit breakers are easy to restore. Dismantle, clean, oil, reassemble, check for binding with prussian blue and tissue paper.

Motors. Disassemble and hose with fresh water. Clean, dry and oil the shafts and bearings. Next, dry stator. Easiest way is in an oven at 95C. Otherwise, apply low voltage to winding and external heat. Don't let internal temperature exceed 80C. If temperature does not come up to this, either raise voltage or cover with canvas or box. Ventilate in all cases to get rid of moisture. If fan-driven hot air is used for drying, keep the air temperature below 100C.

Use same idea with large ac machines, turning at one-quarter speed if possible. This throws water from field, and windage helps dry stator. Heat externally until insulation resistance is at least 50,000 ohms before applying drying current. Cover if needed, but ventilate. With generator, keep at one-half speed until windings are dry to avoid damage from centrifugal force and hot spots. After resistance stabilizes at 1 ohm per 1000 volts, bring generator voltage up to 110% normal rating.

To dry slip-ring motors, short-circuit rings and block rotor. Pass ac through stator winding.

Commutator of small dc motors can be dried best with external heat. You may have to remove clamping nut and loosen V ring to remove water.

Same applies for large dc equipment. If generator is dried in place, you can speed up process by rotating slowly, short-circuiting armature and applying weak field through shunt-

field winding. Do this carefully. Incorrect connection can result in rapid voltage build-up, causing serious damage. A properly set circuit breaker or fuse will help avoid trouble. There are no short cuts for drying commutators, so proceed with caution. Large machines may take two weeks.

Arresters. Disconnect lightning arresters from system. Consult maker before cleaning, repairing.

Batteries. Let them sit. Moving may cause more damage than the flood. Afterward, siphon off as needed and refill with electrolyte. Disconnect terminals and remove connecting straps to prevent corrosion, electrolysis, short circuits.

Cables. If one or both ends are flooded, plan to replace. It may be cheaper to replace than to dry. Braid and rubber-covered cables might be salvaged with little trouble. When returning power cable to service, use 100 megohms as minimum resistance.

Relays and meters. For plants having cubicle-type control board, try the following. After shutting down, disconnect flexible-wire jumpers between terminal blocks on rear of each door and cubicle. Using a crane or block-and-fall, remove doors —complete with relays, meters and wiring. Stack them on a truck and take them to a safe place.

For older-type switchboards, remove as many relays and instruments as possible. Mark wiring for easy reinstallation. Keep enough parts on hand to equip at least one unit. Parts can be obtained from overhauled or idle units.

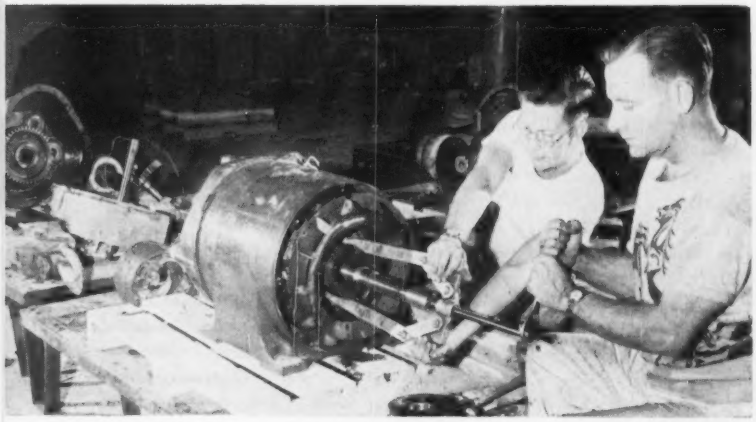
When flood recedes, don't remove covers until you hose down instrument board, using a low-pressure stream. Combination of compressed air and reflector heaters will clean and dry switchboard and wiring. Follow this with a good brush down. Switches and contactors may be cleaned and overhauled without removing. Small motors may be dried in place by removing the rotor and inserting a suitable lamp to supply heat.

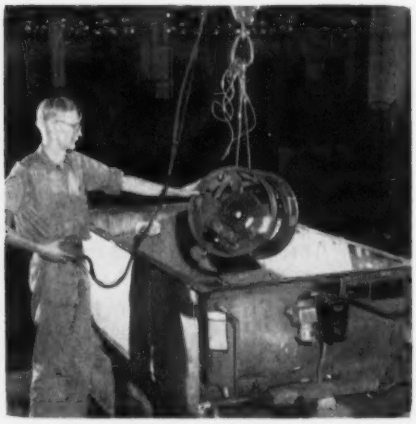
Conduits, control wiring. Be-

Use this field-tested guide of things to do . . .

- Set up emergency headquarters as quickly as possible after a flood.
- Provide briefing for employees returning to work. Advise them of danger zones, safety requirements; provide for eating, personal comfort, first aid; see that locker rooms, service rooms, toilets are usable.
- Guard remote areas from curious and thieves. Use pass system.
- Make one person responsible for health and sanitary conditions. Have him tag drinking fountains, toilets, wash basins approved for use.
- Have one man supervise safety practices; logically your safety engineer. Make this a full-time job. Unusual tasks, plus excitement and fatigue, create unusual hazards.
- Maintain routine records. You'll need them to settle insurance claims, tax deductions, legal questions, payroll arguments. Assign people to gather data, take photos. How about out-of-pocket expenses?
- Encourage imagination. Only real ingenuity will solve many of the problems. Think of similarities, differences, substitutions between objects that might serve some emergency purpose.
- Send as much damaged equipment as possible back to manufacturer for overhaul or, at least, send it to a service shop. You will need your available talent and space for things that can't be sent out.
- Assign long-range responsibility, beyond immediate emergency. Be sure temporary repairs are redone to permanent specs. Check conditions when in full operation, then again in 90 days.
- Make a check list so you won't overlook anything.
- Spread authority to act through all shifts. Important decisions often must be made at night or some other time when you are not there.
- Use more than enough guards; specify what you want watched.

Lean heavily on electrical manufacturers' service shops. You'll





. . . and things to avoid when the pressure is on

- Don't be overcritical of people and their work. Everyone will be anxious, tired, tense. Exercise self-control. Show appreciation for effort. Give clear instructions. Many tasks will be new and unusual to workers.
- Don't waste time trying to reclaim something that's cheaper to replace. In this category: cardboard, stationery, oil and much instrumentation.
- Guard against the danger of spontaneous combustion. Wet rags, paper, can start to burn within 24 hr if ignored and conditions are right. If you can't dry or spread them, keep them soaking wet.
- Don't wait too long for local services and supplies. Place orders outside your geographical area. Ask suppliers to help locate sources.
- Lightning can strike twice, so protect against recurrence. For instance, flood silt raises river bottoms, makes the danger of recurring floods even greater.
- Don't spend time on cleanup until key jobs and critical situations are under control. There's plenty of time later to scrub floors.
- Don't lift emergency precautions too soon. Full recovery takes time.
- Don't be overcautious. Use good judgment, weighing risk of shutdown or slight damage to a questionable system against its value if it works and/or the cost of breakdown.
- Don't work crews over 12 hr to regain production loss. Use two or three shifts instead. Provide time off and vacations as soon as people can be spared, to allow them to recover after the ordeal.
- Watch your own health. The road ahead will need strength, courage and vitality.
- Don't quibble with your union over small change during initial stages, but get back to normal quickly. Most unions will co-operate in recovery.

fore flood hits, waterproof openings. Muslin, packed around wires in conduit ends, makes a good base for waterproofing compounds. Oakum and marine glue are also good bases. And, if time is short, you can use plaster of paris or roofing compound. Check plans to locate all openings.

To dry underground wiring, feed heated compressed air into openings. Megohmmeter will tell when wiring is dry.

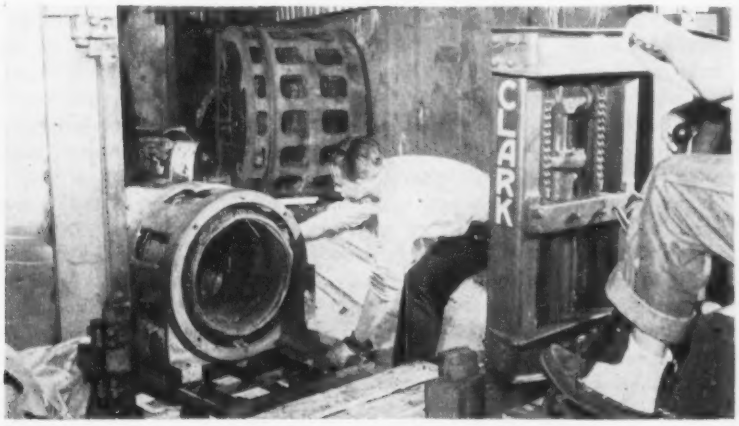
Drying with infrared is faster than other means. Heating is in open, so free air circulation carries water vapor away as quickly as liberated. Be careful not to overheat the insulation by setting lamps too close to the windings.

Switching. When incoming feeders tie into a bus with circuits from another station, provide for temporary switching or jumper connections on the takeoff structure. This helps maintain service to outlying plants. Then, when final shutdown comes, the distribution system remains continuous, even though tie bus is out of commission.

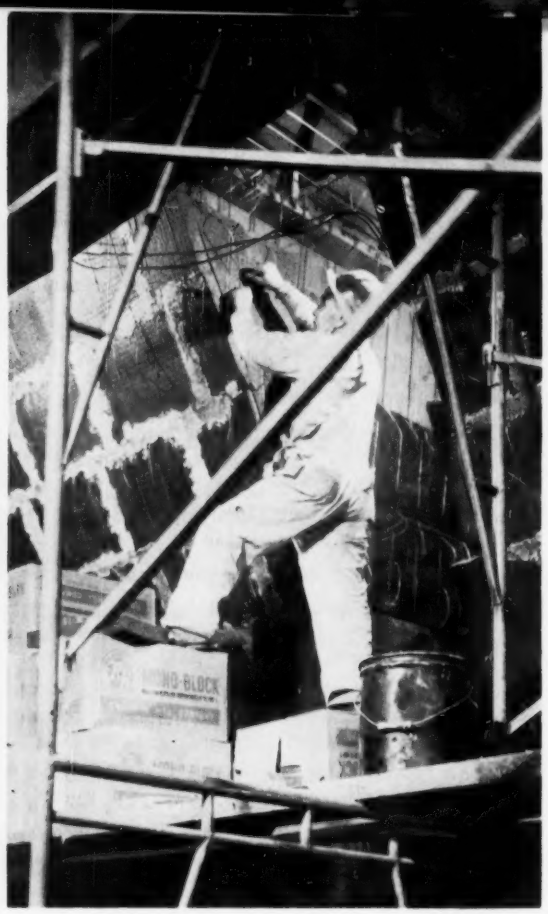
Repair stations. Most electrical-equipment manufacturers have repair and service stations scattered throughout the country. Some are large, some small. However, most companies have organized plans for enlargement in emergencies. During the floods in New England and Kansas City (Mo.), emergency crews were flown to the stricken areas. Engineers and specialists capable of supervising and doing repair work on a large scale moved in and immediately started on the task of getting industry back on its feet.

If the facilities owned or operated by the various manufacturers are not large enough to do the job, they will rent more space. In a matter of a day or two after the flood hits, and often before water recedes, these equipment makers start "operation emergency." Their aim is to get industry operating again as fast as possible. From receipt of a water-soaked item, to delivery of a freshly painted ready-to-go unit, their facilities are geared to do a first-rate job.

find them ready with extra help to get your equipment rolling



FOUNDATION for blocks is wire base welded to stiffeners. Insulation is tied to rods slipped under wire and welded at one end



SPACE METHOD progresses in unbroken flat surface on economizer, needs no special effort to cover flanges and stiffeners

Modern insulation techniques provide . . .

The heat barrier at River Rouge

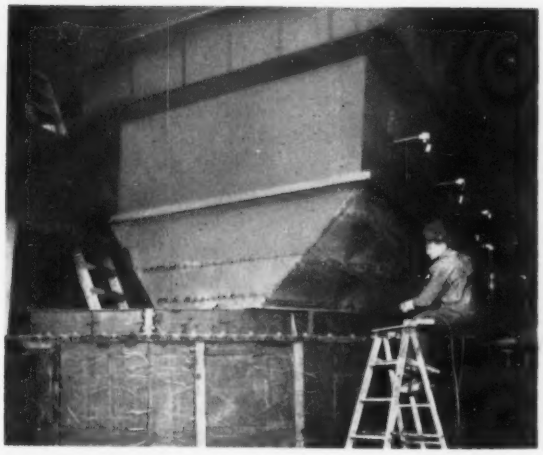
The versatility of modern insulating materials, both in composition and adaptability to installation techniques, came into play at Detroit Edison Co's River Rouge Station. To get optimum dollar—and thermal—efficiency, the station used two spun mineral-wool types, three application and three finishing methods in tailoring a heat barrier for its new 1,720,000-lb-per-hr steam-generating unit which went into operation in November 1957.

Basic material used was rigid mineral-wool block because of its high-temperature capability, structural strength and ruggedness. However, the boiler-skin casing's relatively large and regular areas were well-suited to an insulation having a large unit area. Special 4-in. thick metal-mesh spun-mineral-wool blankets were developed to give high thermal efficiency and to cover waterwall casing surfaces.

Impaled on studs welded to the casing, blankets were secured with speed clips and laced to each other with No. 16 wire. Inner face of a 1-in. metal-mesh reinforced blanket and an expanded metal lath added rigidity to the outer surface. An outer shell built up of aluminized sheet-steel panels protects the assembly.

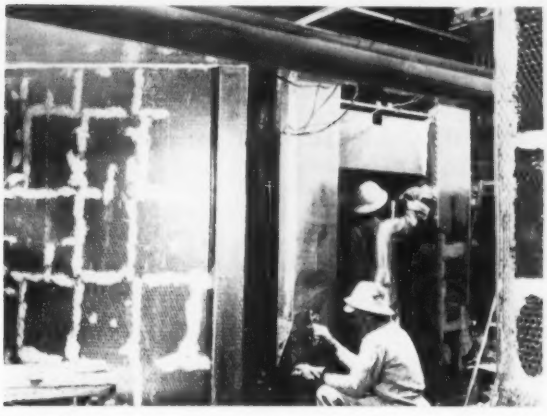
Where duct configuration permitted, the spaced method was used to apply standard mineral-wool block to the cold-end equipment and connecting ductwork. With this method duct stiffeners rather than duct surface act as attachment hardware foundation. This leaves air space equal to stiffener height between hot surface and inner surface of the covering block.

Crimped wire, tack welded to economizer stiffeners, was first step in applying space method. Next, ¼-in. steel rods inserted on 6-in. centers beneath the crimped wire were welded at one end only to allow for expansion. At least three 16-gage tie wires secured each block to the rods. Besides adding to the dead air space's insulating value, this method simplified the job. Protruding flanges and stiffeners didn't need special treatment—built-up sections of block or half-sections of molded pipe

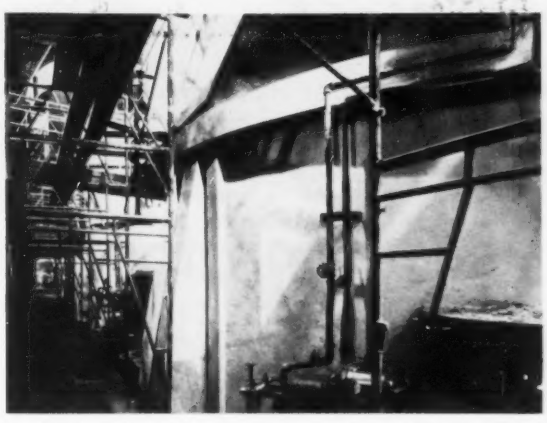


SMOOTH SURFACE permits direct attachment. Width of block determines spacing of base wire which is welded directly to plate

SHEET-METAL LAGGING protects insulation on air-preheater gas outlet. Pointing joints with special cement completes thermal seal



WIRE MESH tied over insulating block reinforces the insulating-finishing cement. Bead is used to secure all sharp corners



FINISHED with white special cement, the insulation is efficient, has attractive appearance, can be painted without a canvas cover

covering—because insulation's primary course covered both projections and flat surfaces.

Where possible, such as on internally stiffened ducts, blocks were secured directly to the surface. Crimped wire was tack welded on 18-in. centers to the duct plate. Blocks laid between crimped wire were secured by at least three wires per block looped under the crimped wire.

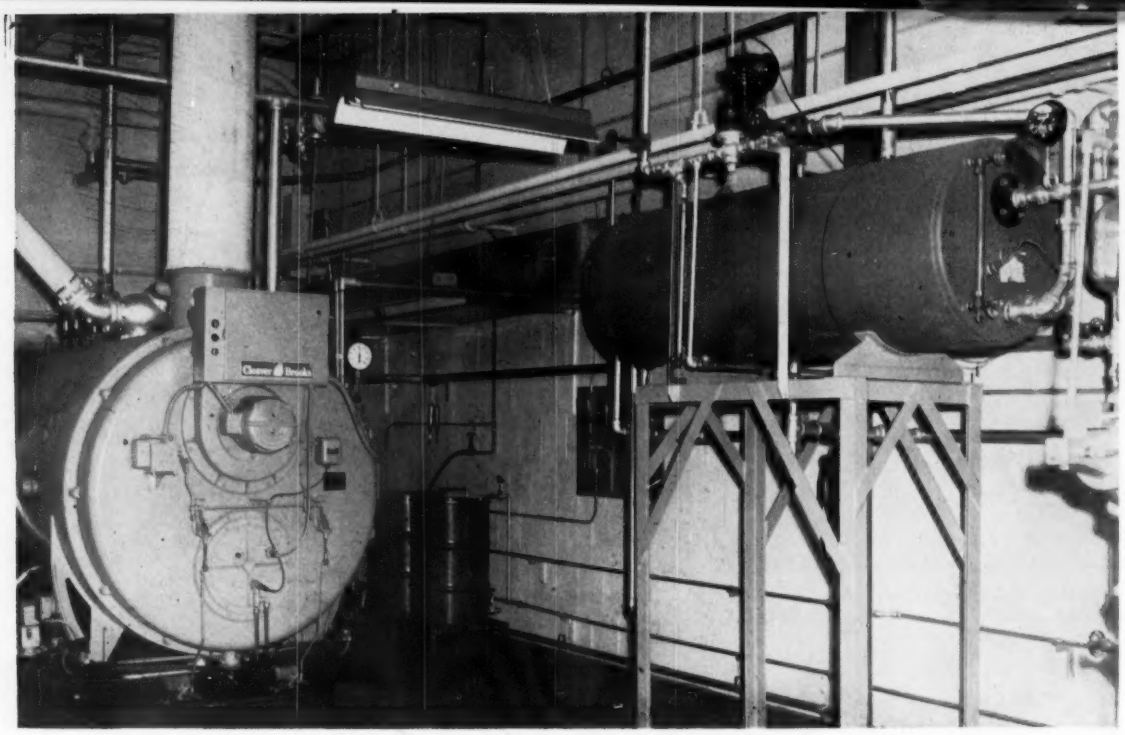
In addition to waterwalls all large flat areas such as air and gas ducts have metal protection over the insulation; 22-gage aluminized steel indoors and .069-in.-thick aluminum panels outdoors.

Panel support joints have provision for both lateral and vertical expansion. Fastener materials were chosen to avoid any possibility of galvanic action.

Irregularly shaped block-insulated indoor surfaces got a ⅜ to ½-in. coat of white mineral-wool insulating finish cement. This was applied to block surface over reinforcing wire mesh held by tie wires securing the block. After the cement was finished-trowelled, the smooth white surface was suitable for painting; it didn't require an expensive canvas covering.

A double mastic-membrane finish weatherproofed the outdoor cement surfaces. First, a tack coat of asphaltic mastic was trowelled over the cement and a glass fabric was pressed into the sticky surface. After a minimum 24-hr drying time the process was repeated. Finally, the second membrane was sprayed with a thin mastic finish coat. This combination of alternate tack coat and membrane plus finish coat produced an impervious dry film about ⅛-in. thick.

Except for the 4-in.-thick special blanket areas, all surfaces needing more than 2½-in. insulation got two layers of block. Joints were staggered, pointed with insulating cement; beading reinforced all sharp corners before the finish cement coat went on. Where possible, cement was applied when unit was operating to minimize effect of thermal expansion. Mastic weatherproofing went on only after the cement was moisture-free.



Packaged-boiler systems benefit greatly from a deaerator. To get top performance from your setup, check this up-to-date info on . . .

Deaeration for the small plant

By R F SCHAUB, Vice President, Fred H Schaub Engineering Company

Dissolved oxygen and carbon dioxide are the prime causes of corrosion in boiler tubes, steam lines and condensate-return lines. Since benefits of removing these two gases are well known, deaerators are invariably used on larger boiler installations. Benefits derived far outweigh cost for the equipment.

Deaerators for most small plants are relatively expensive because certain components in conventional deaerator design don't lend themselves to scaling down. And quick load changes often found in small plants make efficient operation more difficult than larger units with surge tanks, transfer pumps and other auxiliaries promoting steady water input.

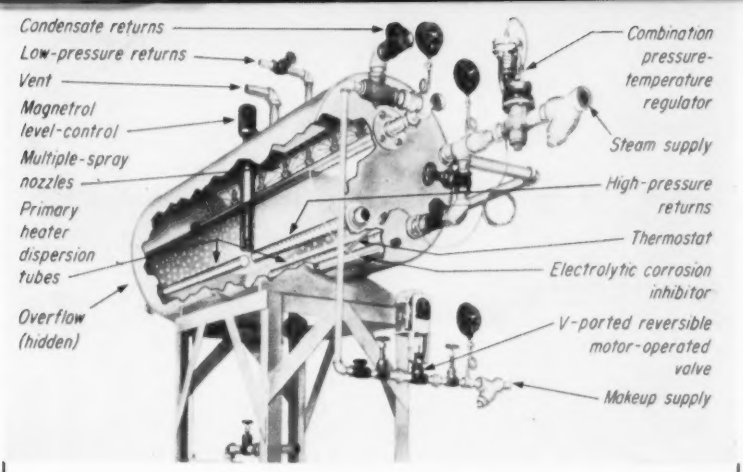
Today, however, there are simple mechanical designs that follow abrupt load changes easily and deliver deaerated water to the feed pumps continuously. Design shown on facing page will reduce dissolved oxygen well below 0.03 cc per liter. That is equivalent to only three parts in 100,000 by volume.

Heat-transfer efficiency is improved by reducing the amount of air going off with the steam. At any given boiler pressure, air-free steam gives you more for your fuel dollar. Deaeration also reduces the amount of chemical additives needed to combat corrosion selectively.

Return-line corrosion is a big problem in many plants. It occurs more often on low-pressure systems using vacuum pumps rather than on high-pressure return systems. And it can happen even when there is very little raw water makeup to the system.

Condensate-return samples invariably contain carbonic acid. Take the case of a system with little or no free carbon dioxide in the small amount of makeup. The water supply will contain bicarbonates that break down under heat, releasing carbon dioxide as a byproduct. It's an impotent gas as long as there isn't any oxygen present. But when steam is condensed at load or process, resulting condensate flow from traps rapidly cools below the boiling point. This cooled condensate takes carbon dioxide into the solution, forming carbonic acid.

That, alone, is enough to start chewing away at the return line. But when air, (20% oxygen by volume) enters the act, accelerated oxygen attack takes place and the return line gets both barrels from the corrosion shotgun. You can install corrosion-resistant piping, but this only shoves the problem to another part of system.



Here's how this deaerator works

As deaerated water is removed by the boiler-feed pump, the level controller actuates a motor-operated valve in response to level change. Note that the inlet valve opens only if there isn't enough condensate to maintain water level. Steam enters through a pressure-temperature regulator. The thermostat is set for 211 F and responds to a 0.25-F temperature change in deaerator storage. Steam then passes to primary heater dispersion tubes and is released through a large number of small orifices. Resulting jets of steam produce controlled agitation with a scrubbing action that effectively separates air from water. Noncondensable gases, including oxygen and carbon dioxide, discharge freely through the open vent. Condensed steam returns to deaerator storage. High-pressure returns enter through a separate perforated header. Gravity low-pressure returns enter the top of the receiver where they pass over a splash plate. Pumped condensate returns enter the supply line downstream of the control valve.

A deaerator helps to solve the problem in two ways. First, it does the job of removing practically all dissolved oxygen picked up in the return line. Second, since the deaerator is actually a heater too, it breaks down some of the raw water bicarbonates and removes the resulting free CO_2. This further reduces the possibility of getting CO_2 in the return-line system.

Operating cost is low. All boiler steam used in the deaerator is absorbed by the feedwater and returned to the boiler. In fact, where there is waste steam, it can be used by the deaerator to produce a saving.

Cost in relation to boiler-horsepower is attractive on sizes as small as 2000 lb per hr (about 60 boiler-horsepower). The same basic design can be used up to 50,000 lb per hr.

Deaerator, facing page, handles a normal summer load of 3000 lb per hr. Winter load increases to 7500 lb per hr at 100 psig. Boiler feed consists of 20% makeup and 80% condensate returns. After initial setting of the temperature-regulating valve, the system adjusts itself automatically to any load changes that follow.

The heater tubes normally work at steam pressures up to 5 psig with the water inlet spray manifold between 5 and 10 psig. The deaerator shell itself is completely vented to insure continuous removal of all noncondensables released in the deaerator. At the same time it is completely safe since the unit doesn't have to depend on a relief valve. Low-pressure construction also keeps shell cost to a minimum.

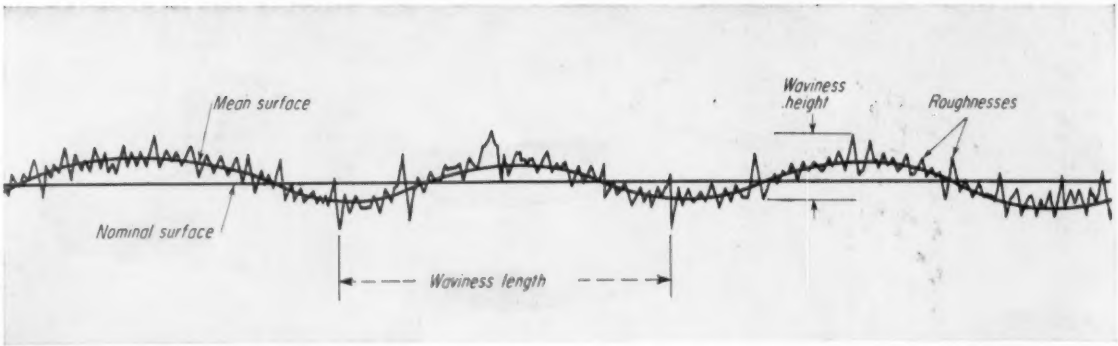
The tank itself is normally given a rustproof lining at a cost much lower than an all stainless-steel or cast-iron construction. The unit is equipped with a magnesium electrolytic corrosion inhibitor to guard against galvanic corrosion.

For plants with tight new equipment budgets there is another type heater available. It removes 90% of the oxygen at about two-thirds the cost in any given size. Basic operating principles are similar but some of the refinements are omitted. For example, the pressure-temperature regulator is not as sensitive and costs less. It keeps receiver water temperature in the range of 205 to 208 F. At these temperatures, very little steam from the submerged heater tubes breaks off at water level. This eliminates need for vent condensing apparatus. Makeup control will usually be an inexpensive on-off type.

Because of lower feedwater temperature, only a few feet suction head is needed, using a properly selected feed pump with good npsh characteristics.

In fact, this is a good time to dispel the notion that twelve to twenty feet elevation is always needed for boiler-feed pumps hooked up to a deaerator. This is true with most types of reciprocating or conventional centrifugal-feed pumps, but a well-designed turbine pump with good hot-water handling characteristics needs only six or seven feet maximum elevation at moderate operating pressure. On some jobs, three feet of submergence will prevent pump vapor bind.

Elevation is very important in today's low-ceiling boiler rooms. New low-head packaged-boiler designs now make this the rule rather than the exception. So deaerator elevation must also be kept down to realize the full cost benefits of lower ceiling boiler-room installations.



ORIGINAL SURFACE ROUGHNESS. Magnified profile drawing shows waves and minute roughnesses of a typical machined surface

PART II OF A SERIES. By E S REYNOLDS and J R HICKS, Socony Mobil Oil Co, Inc

What causes failure of today's gears?

Surface roughness, mechanical damage or abrasives in the lubricant are three reasons. Finding out why these troubles crop up can save you downtime

In the first article of this series, we discussed gear types and lubrication. We concluded that when well-designed carefully made gears are installed, lubricated and operated properly with correct lubrication during run-in, the rolling and sliding action of the teeth tends to smooth out surface imperfections and to work harden and polish the surfaces. Then, with continued proper operation and lubrication, the gears usually run for a long period with few or no signs of wear or distress.

But some gears do fail—occasionally by tooth breakage, but more often because of tooth-surface damage. Finding out why this happens helps to avoid costly replacements and loss of production time.

The many types of gear-tooth failure present a confusing variety of patterns. Many names have come into use describing the appearance of the failures, for example: spalling, pitting, galling, scoring, scuffing, scratching, abrasion, gouging, peening, rippling and ridging. Some people use the same name for different types of failure and more than one name is often used for the same type.

After years of study, we conclude that there are five basic causes of gear-tooth failure: (1) original surface roughness (2) mechanical damage (3) abrasive contaminant in the lubricant (4) metal failure (5) lubrication. This article considers the first three causes.

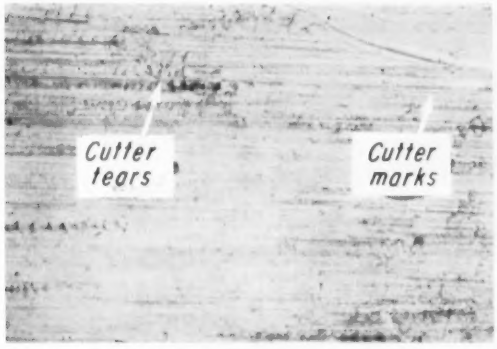
Original surface roughness. Like other mechanical surfaces, gear-tooth surfaces are not perfectly smooth. Their contour is invariably wavy, and superimposed on the waves are minute "hills" and "valleys" as diagrammed above. The surface waves can be measured with conventional precision dial indicators. The minute roughnesses are measured in millionths of an inch, with special instruments.

Photos, top of facing page, show magnified views of a carefully hobbed and a hobbed-and-shaved gear-tooth surface. There is considerable evidence that surface "roughness" is the basic cause of a common gear-tooth failure called pitch-line pitting (see bottom photos, facing page).

The oil film is very thin in the contact area along the pitch line—often thin enough so actual boundary lubrication conditions prevail. That is, high areas may make actual contact through the film. In any case, they are more highly stressed than adjacent areas. Toward the tips and roots of the teeth where there is a high ratio of sliding to rolling action, the high areas are worn away and the surfaces smoothed up. Smoothing will not take place to the same extent at and near the pitch line where rolling action predominates. (The sliding velocity between mating teeth comes to zero at the pitch line, and the direction of sliding reverses at this point.)

Pitch-line pitting. At the pitch line, high areas that come together are repeatedly stressed above the fatigue

Gear teeth look smooth, but magnification tells another story

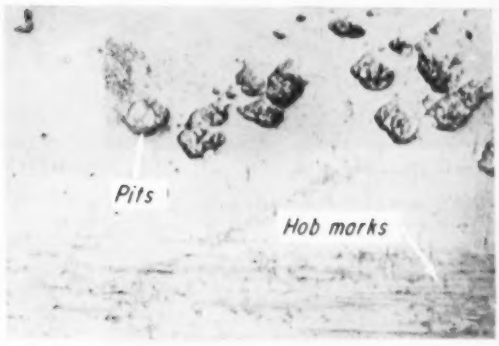


Hobbed tooth

Cutter marks and tears are visible on this carefully hobbed tooth. This is one form of original roughness

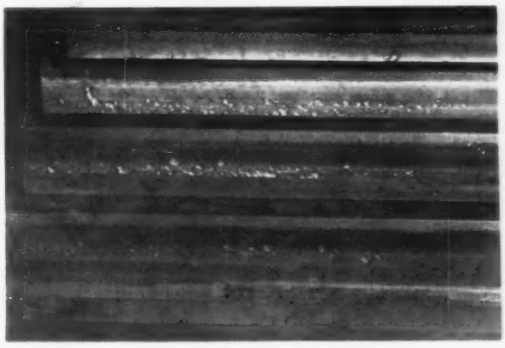
Hobbed and shaved

Shaving doesn't eliminate surface roughness. High spots remain, will cause heavy stresses as teeth mesh



Pitch-line pitting

Repeated overstressing of high spots formed by original surface roughness causes fatigue pits on pitch line



Destructive pitting

Continued heavy loads may overstress edges of pitch-line pits, cause progressively more metal to break away

endurance limit of the metal. Fine cracks form, grow and join. After many cycles, fatigue failure occurs. High spots break off and drop out, leaving small pits.

There is some variation of metal structure and hardness from one area to another across a gear tooth. This variation is believed to be a factor in pitch-line pitting since it affects fatigue resistance.

Gear-tooth surfaces can be smoothed considerably by lapping. And the fact that lapped gears rarely develop pitch-line pitting tends to substantiate the theory just described. To be most effective, lapping should be done on a machine designed to process the entire tooth surface. Merely running gears together using a lapping compound does not lap the pitch-line surfaces where there is no sliding.

With some spur gears, pitch-line pitting is not serious and ceases after initial formation. Further operation has a peening effect that smooths and work hardens the surface so pits may actually disappear. This is called corrective pitting.

With heavy loads, however, the edges of pits may be overstressed and break away so the pits grow. The metal nearby, especially toward the roots, may fatigue and pits may form over a considerable area. This is referred to as progressive or destructive pitting.

Loads at or near the pitch line can be quite heavy since in this area one pair of teeth usually carries entire torque load. At beginning and end of mesh, the load is usually shared by two or more teeth.

With helical gears, pitch-line pitting is usually the corrective type. The line of contact slants from the root to the tip and, even after a pit is formed, the load is carried both above

and below it on the sound metal.

Pitch-line pitting is not caused by faulty lubrication. Destructive pitting can be stopped by reducing load or changing to more suitable gears. In border-line cases, using an oil that is heavier-bodied (has a higher viscosity) than normal may help by providing films that are thick enough to keep high areas of mating teeth well separated.

Mechanical damage includes bent, broken and scarred teeth. Immediate causes include large objects such as a nut or a piece of broken tooth going through mesh, and accidental blows to the teeth received during shipment or erection of the unit.

The scar trails, top photo, right, were caused by metal objects going through mesh. Gear ratio was such that there was a hunting tooth—every pinion tooth eventually contacted every gear tooth. So damage was transferred to all teeth.

Next photo shows a pinion that was dropped during assembly, bending some teeth. The gear ratio was such that pinion damage was transferred to every tenth gear tooth. High areas resulting from mechanical damage cause local loads so high that lubricating films cannot prevent damage transfer to mating teeth.

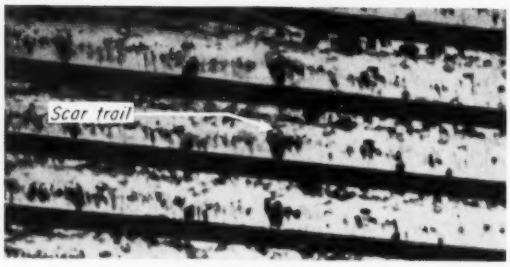
Abrasives, foreign material. Gritty, coarse material, such as sand, rust and pipe scale, scratches and wears gear teeth. Abrasion, third photo, was caused by dirt and metal particles in the lubricating oil. Scratches are most prominent near root and tip, where sliding is the greatest. At the pitch line, gritty material has been rolled into the surface, but there is no scratching since there is no sliding action at this point. Below the active part of the tooth flank, you can see original machining marks.

Fine materials in the lubricant cause a lapping or polishing action. Tooth surfaces may look smooth, but wear may be excessive.

Hard metal chips dent tooth surfaces, bottom photo. Soft metal particles, such as babbitt from bearings, do little or no damage. Only cure for foreign material in oil is to filter the oil, clean the system and eliminate source of contamination.

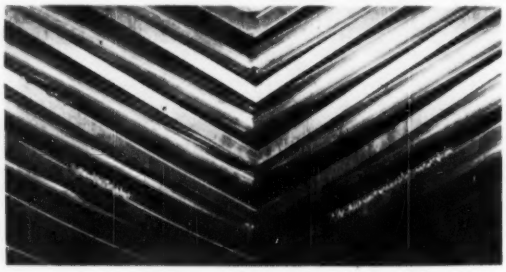
Next article in this series deals with metal failure as the fourth basic cause of gear failure.

How mechanical damage and abrasives affect gears



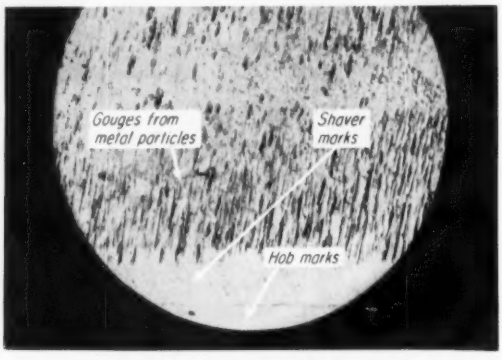
Scar trails

Metal objects, going through mesh, scar teeth. Damage to one tooth may be transferred to all, leaving a trail



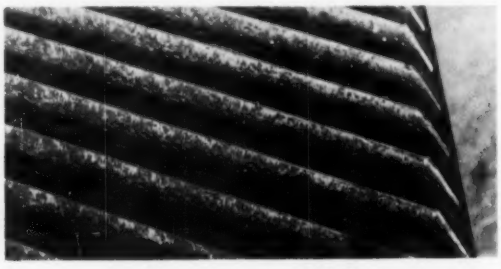
Bent teeth

Accidental blows may bend or otherwise damage teeth. This pinion was dropped during assembly



Abrasive in lube

Gritty foreign material in the oil scratched and gouged this shaved gear tooth, particularly near root and tip



Foreign material

Hard metal chips going through mesh caused these dents. Soft metal, like babbitt, would do less damage

How I would hook up emergency water supply

EDITOR'S NOTE: *The passage of time often sees rekindled interest in* Plant Problems *presented earlier in* POWER. *Here's a case in point:*

Hooking up an emergency water supply for a 160-bed hospital, using 30,000 gpd, was a problem (POWER, Nov 1956, p 140). Normal source was an 8-in. city main, lime-soda softened. Well water was probably available at 100 to 125 ft depth. Hospital had two electrically driven booster pumps intended for a future fifth floor, but presently used only when city pressure was low. These were not connected to the emergency generators. Continuous water flow was vital.

Here's how I would solve this problem. I would supply all water needs through two roof-top tanks above the future fifth-floor level. Pumps should be connected to the emergency generators, through a double-throw switch.

If the well has adequate capacity for normal needs, pump all water from the well; use the city main for emergency standby. Operate pumps on off-peak power periods.

Get architect's advice on strength of existing structure. The usual hospital wing could support two parallel tanks of slightly less than 30,000-gal capacity each (13-ft dia, 30-ft long). Figuring on ¼-in. thickness, each tank (dry) would weigh about 13,175 lb; water, about 248,150 lb per tank. Total gross weight of both tanks is nearly 262 tons.

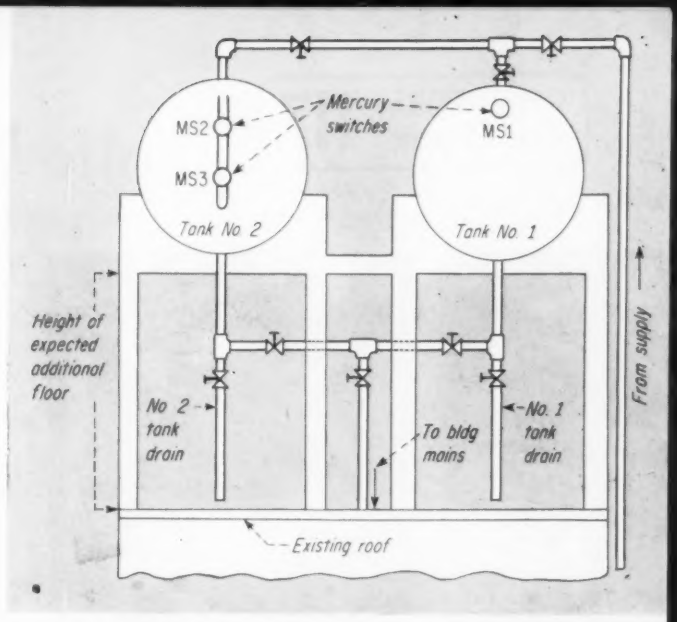
With pumps in the basement, the discharge head would be 70 to 75 ft. Suction depends on depth of well and underground pressure, if any.

Using two tanks fitted with manholes and connected as shown in top sketch permits supplying the hospital from one while the other is cleaned or repaired. Tanks should be well vented, have a common overflow connection.

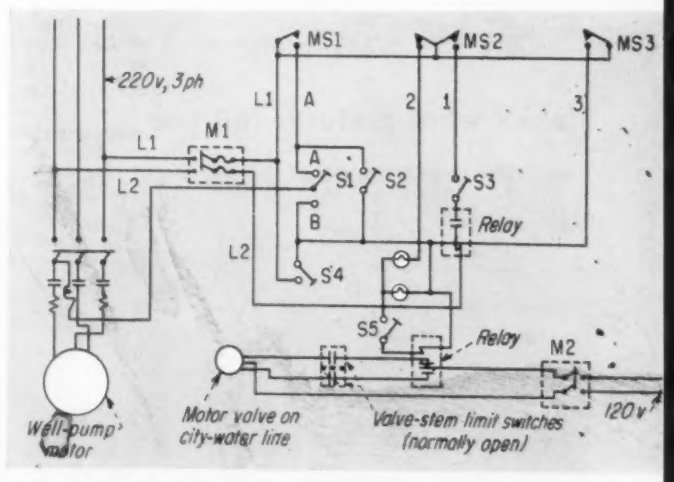
Conserve water for cooling auxiliaries by using a cooling tank, with a float-operated valve for makeup.

Two conventional mercury-bulb boiler low-water switches and one high-water switch with an opposite contact bulb at *MS2*, sketch, control tank level. Mercury switches are shown in full tank position. Contacts are shown as knife switches in wiring diagram, but can be easily incorporated into a 10-position rotary switch.

JOHN JENKINS, *San Diego, Calif.*



ROOF-TOP TANKS above future fifth-floor level supply all water needs



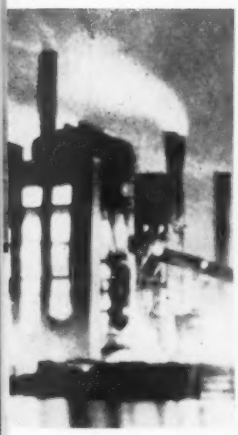
WIRING SETUP permits nine control circuits plus "off" position

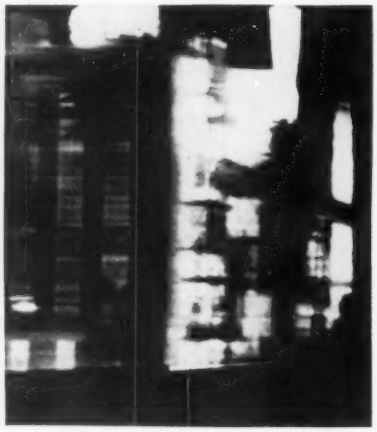
Switch positions for control circuits

Control circuit desired	Switch S1	S2	S3	S4	S5	M2
Pump only, through No. 1 tank; valve in reserve	Close A	Open	Closed	Open	Closed	Closed
Pump & valve on No. 1 tank	Close A	Closed	Open	Open	Closed	Closed
Pump only, through No. 2 tank	Close B	Open	Closed	Open	Open	Open
Pump & valve, through No. 2 tank	Close B	Open	Closed	Open	Closed	Closed
Valve only, through No. 1 tank	Open	Closed	Open	Open	Closed	Closed
Valve only, through No. 2 tank	Open	Open	Closed	Open	Closed	Closed
Pump & valve, manual control	Close B	Open	Open	Closed	Closed	Closed
Pump only, manual control	Close B	Open	Open	Closed	Open	Open
Valve only, manual control	Open	Open	Open	Closed	Closed	Closed

OPERATORS' NOTEBOOK **117**

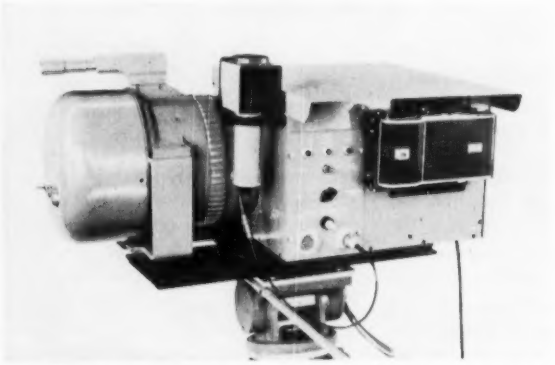
Now, heat pictures





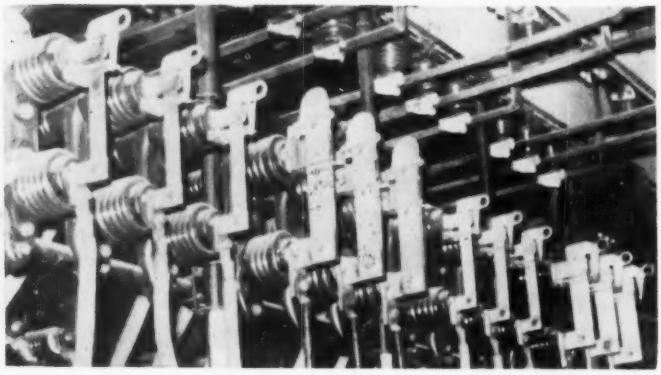
POWER PLANT photographed with black-and-white film, then with thermal camera. Hot objects appear light in second photo

This is how the camera works

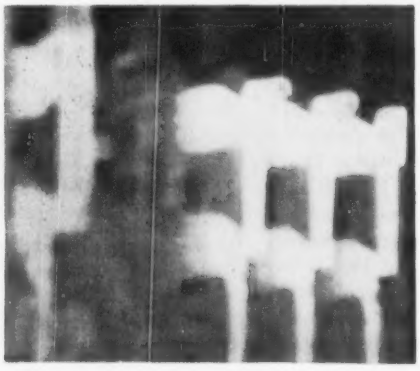


INFRARED CAMERA, showing radiometer with telescopic sights, scanning mechanism and polaroid camera for recording results

Here's what pictures tell you



VISUAL PHOTO of electric switches shows only what the eye can see. Since there's no indication of overheating, you would assume conditions to be normal



HEAT PHOTO shows that three of switches are at a much higher temperature—up around the 110-C mark

Things you should know

A revolutionary new camera for taking "heat pictures" is bidding in as the latest trouble-shooting tool. It takes thermal photographs by shooting the infrared radiation or heat given off by all objects.

Heat pictures. Whereas conventional cameras use visible light reflected by all objects, this camera detects the infrared radiation and converts it into black-and-white photographs. Each point on the photographic image indicates the heat being emitted by that point and can be converted into temperature readings.

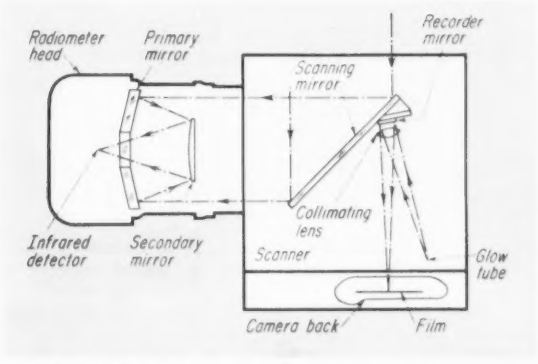
The camera gives a quantitative photographic record of the temperature distribution of the objects pictured. Hence, the heat pictures taken with it can be used in making heat measurements. Special film isn't needed since the image is formed by means of an ordinary light beam inside the camera. So objects pictured in photographs are clearly recognizable; but their black-and-white shading is based on graduations of emitted heat intensity rather than on reflected light.

Complete camera consists of radiometer system for measuring the infrared radiation, a scanning attachment and a visual camera to record the image. Entire assembly weighs about 100 pounds.

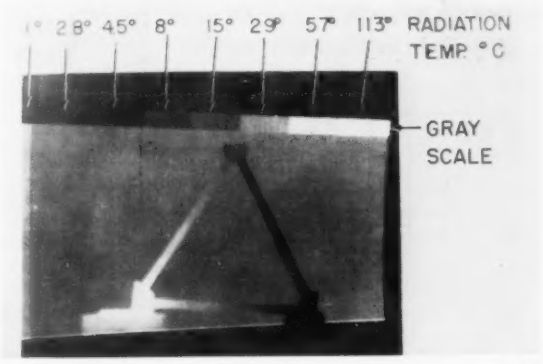
In operation, the camera is sighted on the object to be photographed. Though apparently motionless during exposure, an internal mirror scans back and forth across the field of view for several minutes. An ultra-sensitive fast heat detector in the radiometer picks up the radia-

do your trouble shooting

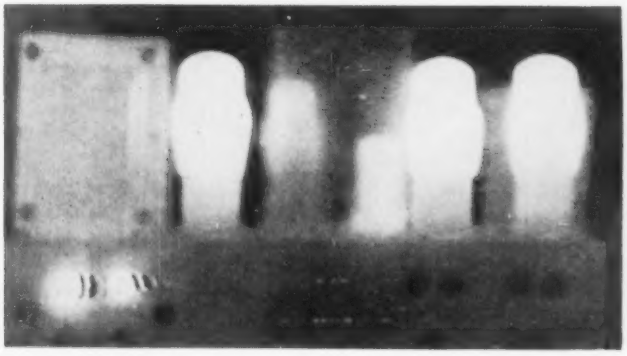
By STEVE ELONKA, Associate Editor



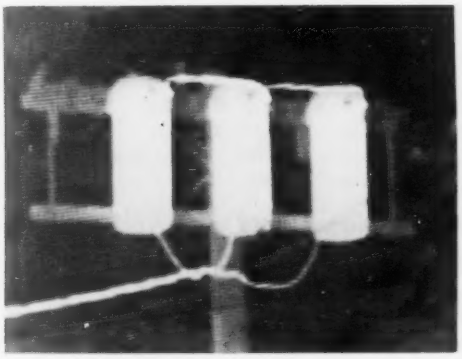
SCHEMATIC DIAGRAM is of scanning system that can be used for any target range within focal limits of the radiometer



TEMPERATURE SCALE. One corner of metal triangle is on hot plate, other on dry ice. Compare temperatures with gray scale



HEAT DISTRIBUTION of electronic chassis shows high temperatures—140 C to low of 23 C. Transformer, *left*, is warmer than other parts of the chassis



TRANSFORMERS and output leads are hot because of heat generated by the flow of the heavy electric currents

tion emitted by various points of the object, modulating a light beam. The more intense the radiation detected, the brighter the beam.

Object or scene being photographed is scanned from top to bottom and side to side just as the image on a television screen. The modulated light beam is simultaneously scanned over the film in the corresponding pattern. Final black-and-white picture is made up of a series of closely spaced lines. Light areas on picture correspond to areas in object emitting the most heat; dark areas mean less heat. Scanning time for a picture varies between 2 and 15 minutes, depending on the sensitivity and the amount of detail required.

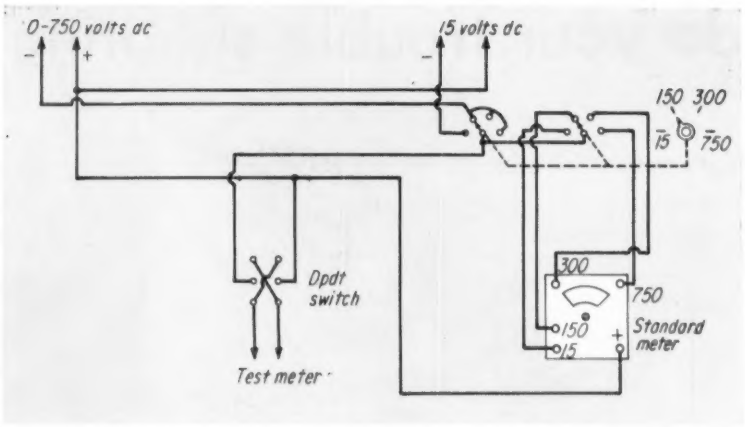
Sensitivity of camera is very high. It can detect temperature differences as small as 0.02 C. Thermal pictures taken of humans show their blood vessels very clearly.

Perhaps widest use for thermal photography is in scanning industrial equipment and processes. A heat picture of a refinery, for example, will show where hot spots—potential sources of trouble—may be developing. Also, picture of a bank of electric switches can reveal overheating of elements in switch contacts.

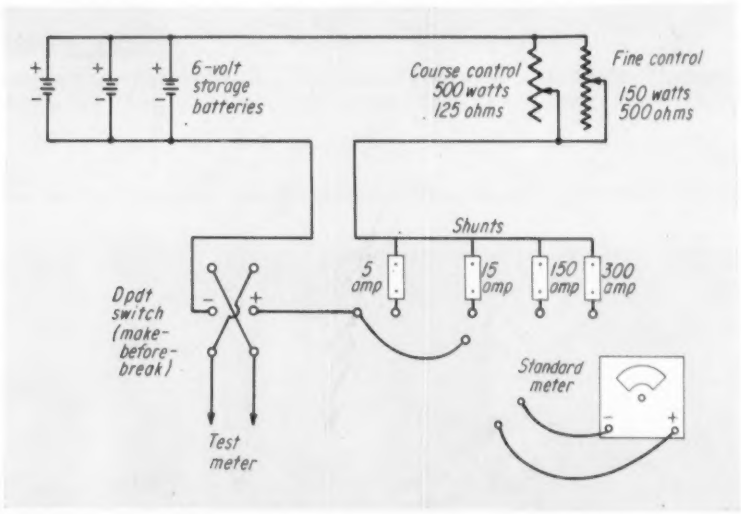
Because thermal photography and infrared radiometry are not dependent on visible light and don't need physical contact, they can be used for quality control. Heat patterns can detect faulty welds, overheated machine parts, defects in metal castings and built-up sections.

—Courtesy, Barnes Engineering Co, Stamford, Conn.

By FRED R MANNING
Allis-Chalmers Manufacturing Co



VOLTMETER calibration setup. Power supply for 0 to 750 volts can be a rectifier or small dc generator. Ten ½-volt dry cells can be used for 15-volt supply needed for low scale



AMMETER calibration setup. Storage batteries must be provided with some means of recharging. Combination of variable resistors is for exact control of the test-meter current

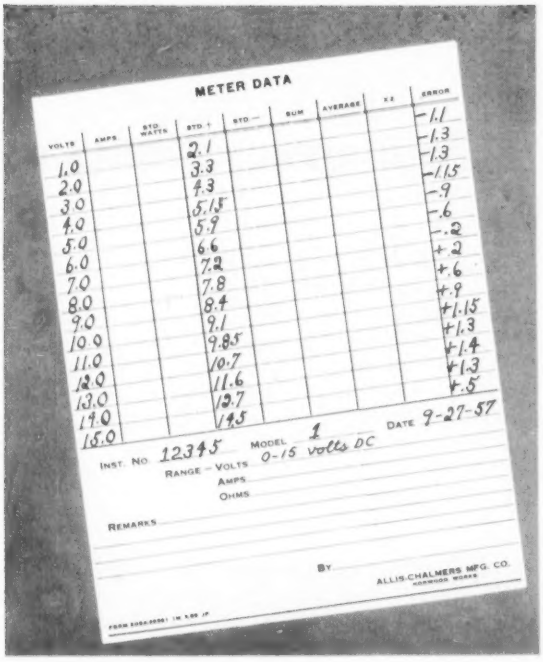
Service ammeters and voltmeters must be accurate. Here's setup to . . .

Keep shop instruments calibrated

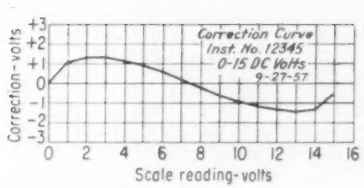
Is one of your maintenance problems the determination of the accuracy of service instruments? For a reasonable amount of time and money you can set up a workable meter-maintenance program. Here's an outline of an acceptable program for keeping up records of meter-calibration data, including schematic diagrams and specifications for the necessary equipment.

Moving coil or galvanometer type instruments are considered only, since a discussion of all types of instruments used in test work is beyond the scope of this article. Instruments may be of the permanent magnet type, as used for direct-current measurement, or the electrodynamometer, or moving-vane types, as used for alternating-current work. Refer to POWER, Nov 1956, pp 130, 131, for basic meter movements.

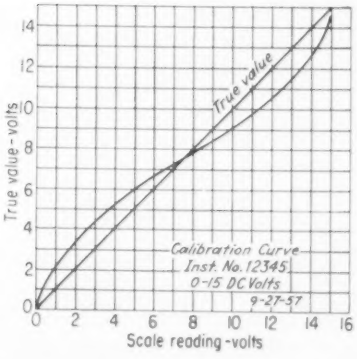
First step is to set up a file system where all meters can be entered and records kept of routine calibration checks. The file can be in the form of a notebook or card system. If card file is used, it could incorporate a tickler system causing the desired card to come up each week, making sure that each meter would receive at least one check per month. When meter checks are made, the calibration chart, facing page, should be filled out. Calibration chart can be



CALIBRATION CHART provides record of meter calibration data. Data can be used to develop calibration curve or correction curve



CORRECTION CURVE for voltmeter shows values that must be added or subtracted


True value
Calibration Curve
Inst. No. 12345
0-15 DC Volts
9-27-57
True value - volts
0 2 4 6 8 10 12 14
0 2 4 6 8 10 12 14 16
Scale reading - volts

CALIBRATION CURVE indicates true values corresponding to voltmeter scale reading

used to develop calibration curve or correction curve. Correction curves are preferable to calibration curves for ordinary use, because errors are more easily detected on the larger scale, producing results that can be read more easily and with greater accuracy.

Next step is to establish the calibration circuit or standard bench. The ideal would be to have what is known as primary standards. These are large dc ammeters and voltmeters, laboratory calibrated, that use a standard cell, potentiometer, standard shunts and resistances.

Cost of these instruments is very high, which might prohibit their use in a small maintenance shop. But service instruments can still be compared to other instruments known to be accurate. The latter should be new, or recently calibrated by the instrument manufacturer. And they should be used for no other purpose than as standards.

Two standard meters are required, a voltmeter with a range of possibly 0-15-150-300-750 volts, and an ammeter with ranges of 0-5-15-150-300 amperes. The ammeter will probably be a millivoltmeter (50 millivolts full scale), scaled for the above current ranges with shunts for these ranges.

Setups for checking voltmeters and ammeters are shown on the preceding page. Power supply for the voltmeter arrangement can be a rectifier operated from 110-volt single-phase ac. A small dc generator may also be used as the power supply, although some fluctuations caused by commutation may be noticeable. A low-voltage power supply is provided because the high-voltage supply may be difficult to control at the lower voltages, especially if generator is used for the high-voltage supply.

Meter checking should be done on the bench where vibration can be kept to a minimum. One thing to remember when checking ac instruments against a dc standard is that readings must be taken with both forward and reversed polarity. True reading is the average of these two readings. This procedure simulates alternating current.

Wattmeters can be checked using both setups—current being supplied by an ammeter test rig, voltage by a voltmeter test rig. True watts is the product of the ammeter and voltmeter readings. When checking polyphase wattmeters, current coils in each phase are connected in series and potential coils are connected in parallel. Multiply the wattmeter readings by one-half before you apply the regular multipliers. Polarity must be the same on both the current and potential inputs. If polarity is not the same, wattmeter will read backwards. To correct this condition, it's only necessary to reverse either set of leads —but not both. Reverse readings should be taken the same as with any ac instrument, reversing both the current and potential lines. This is done, of course, by using the reversing switches provided in the test circuits. Always be careful not to exceed rating of current coils.

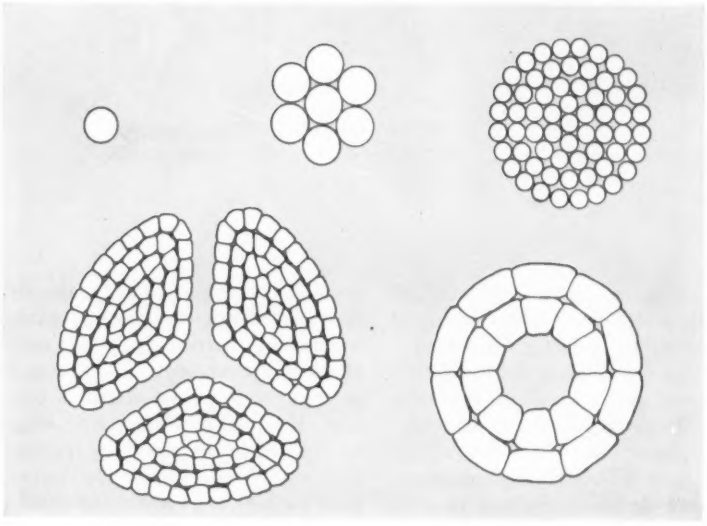
With the test methods described, your electrical service shop will be able to keep its meters accurate by using equipment usually found around the shop. Since no special equipment is required, meter calibration can be carried out with a minimum of expense and effort. Records of calibration will prove a real asset in keeping track of your instruments.

Plant Electrical Fact File

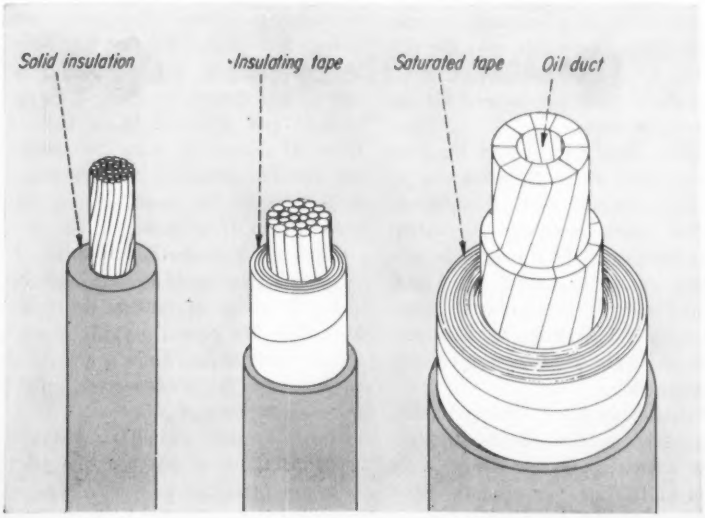
NO. 24: CABLES

Four components of

By NORMAN PEACH, Assistant Editor



1 **CONDUCTORS** are made of copper or aluminum in grades intended to give highest conductivity and best mechanical properties. Conductors should not be too hard, brittle or springy. To get flexibility, cables are stranded. Where extra flexibility is required, fine strands are used. It's generally desirable to minimize diameter of cables in order to save space in ducts and to reduce amount of insulation needed. Therefore, in some multiconductor cables, component cables are squeezed into sectors. Hollow cable with special-shape strands permits insulating oil to be fed through cable under pressure. Oil saturates surrounding insulation.

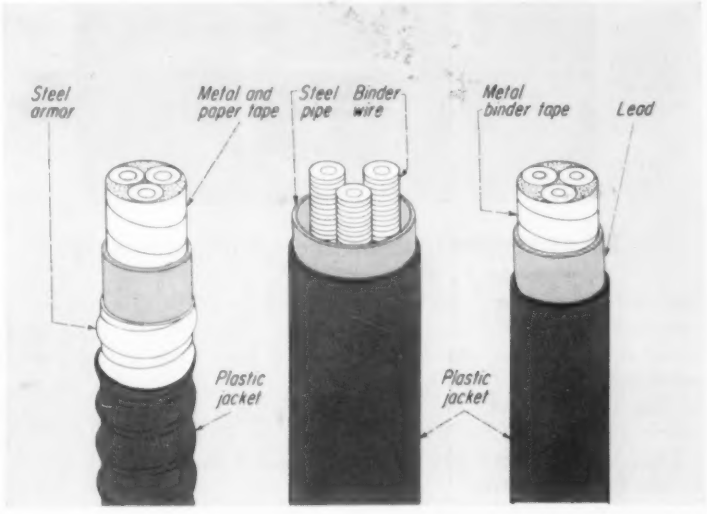


2 **INSULATION** takes three forms. Solid or homogeneous insulation is extruded on to conductor. A great variety of "rubber" and "plastic" compounds are available, such as neoprene and polyvinyl chloride. Overlapping tapes in required number of layers are used for other materials such as varnished cambric, polyethylene and glass fiber. They're usually used for higher voltages than extruded insulation. For highest voltages, an insulating fluid, generally oil but sometimes gas, is forced into cable, saturating solid insulation and excluding air. Paper tape is often used, and a lead sheath retains the oil which must be kept under pressure.

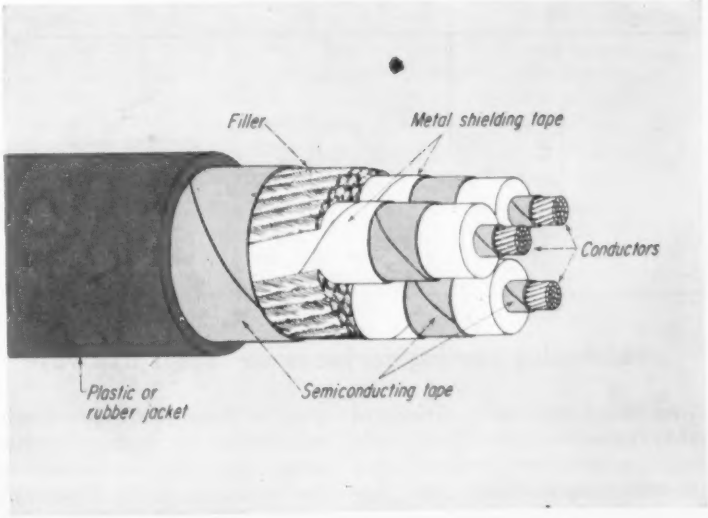
insulated power cable

Electric power cables are made in a great variety to meet special requirements of particular applications. Cable construction, however, has three, sometimes four, basic requirements to meet. It must (1) carry the current without excessive power loss and voltage drop (2) insulate the conductor adequately to prevent failure (3) protect the conductors and insulation against both mechanical and chemical damage and (4) provide electrostatic shielding at higher voltages (usually considered above 3 kv), to prevent damage to the insulation as result of unequal distribution of dielectric stress.

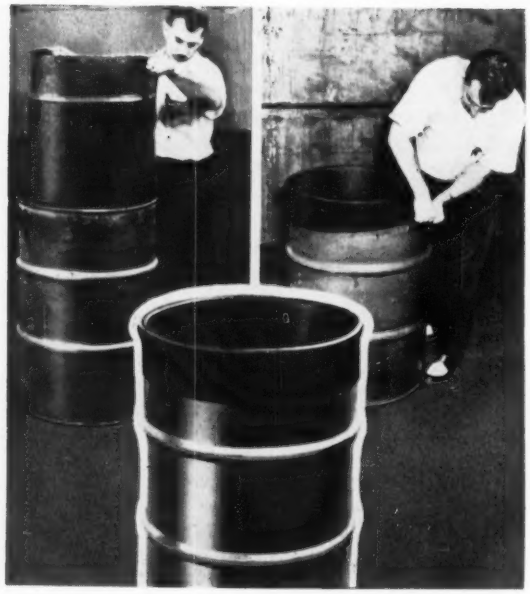
3 **PROTECTION** against mechanical damage and chemical deterioration caused by contaminated atmosphere or excessive moisture is provided by armor or jacket. Cable at left has interlocked armor of steel, but aluminum and bronze armor is obtainable. For particularly corrosive atmosphere, there's a plastic jacket over armor. Lead sheath on cable at right gives mechanical protection, seals in cable, may retain insulating oil. Plastic jacket is sometimes used to check corrosion. In center is pipe-type cable, used for high voltages. Pipe is filled with oil under pressure; pipe joints are fluid tight. Plastic jacket can be used here, if needed.



4 **SHIELDING** is provided mainly to keep surface of insulation at uniform potential, thereby producing more uniform dielectric field in insulation. Unshielded cable runs risk of being damaged by corona in range above 3 kv. Shield is nonmagnetic metal tape, braid or wire connect to ground or at fixed potential with respect to ground. Nonmetallic shield, such as semiconducting tape, helps maintain uniform dielectric field; sometimes it's the only shielding used. Metallic shields also help to reduce (1) the induced potentials in cables connected to overhead lines and (2) the hazards of shock. Remember: metallic shields should be grounded at each splice.



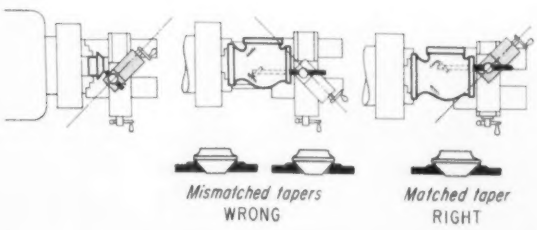
Timely **practical ideas** to help solve



These neoprene drum liners withstand acids

Neoprene drum inserts shown are preformed independent linings that can be installed in any standard 55-gallon drum quickly. Insert is merely set into the drum and the overlap pulled tight over the rim. Molded lip in lining grips the drum rib, holding the insert firmly in place.

Linings are used for electroplating solutions, pickling acid, etc. Neoprene's chemical resistance and good aging properties permit repeated reuse of inserts for various chemicals. These versatile linings can be removed in a few minutes by peeling back the lip and lifting out. Snap-on neoprene lids are also available for use with inserts in close containers. They're real time-savers.—*Courtesy, E I Du Pont de Nemours & Co.*



Matching seating surfaces for safety valves

Worn or damaged seating surfaces of safety valves are remachined as in first two sketches. Here, swiveling the lathe-compound slide from one position to another requires tedious adjustments to produce accurately mated tapers. But mismatched tapers are usually the result. Usual correction is an excessive grinding-in which isn't conducive to good service.

An accurate setup which is simple enough to be overlooked by many maintenance men is shown in third sketch. Here, plug is machined in the usual way. Then, with the same setting of the compound slide, the seat in the valve body is maintained by running the lathe backwards and crossing the boring tool to the backside of the lathe.

No corrective grinding-in is needed. The perfectly matched seating surfaces require only a minimum of lapping-in. This greatly improves the surface quality of seating surfaces.

E WITTMAN, *Villas, N. J.*

Training made easy

Here's an educational plan I started in our powerhouse. Each week for 37 weeks I made up a list of 10 questions about boiler operation, electricity, refrigeration, air conditioning, etc. A copy was sent to each operator, with one week as a deadline to return the answers. At end of week I corrected their papers and returned them with a mimeographed copy of the correct complete answers.

These questions were ones that every stationary engineer *should* know, ones he *must* know to pass the license examination for the City of Buffalo, N. Y.

After 37 weeks, I picked up all their papers. For next three weeks I gave them questions taken from preceding tests. Many were questions that previously had been answered incorrectly or incompletely.

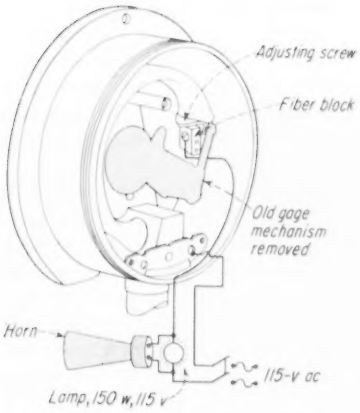
I got the surprise of my life when I scored those 3-week papers. The five men averaged 97%, which I took as proof that our time wasn't wasted.

As a result, four of the five men are still with me. The fifth has moved to a chief's job, one has his chief's license and the other three are ready to take theirs. Hope this idea is useful to others in the power field.

S C STICKNEY, *Tonawanda, N. Y.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor



Salvaged pressure gage is now alarm device

On small projects there are many job classifications known as combination jobs—one man serves in several capacities. On such jobs, one has to do a lot of improvising.

Our 1000-cfm compressor is electrically driven and usually handles the load of jack-hammers and "whirley" type pit pumps with ease. But at times, because of relocation of haulage roads or grade changes, a small deluge of entrapped water comes rushing down to flood the pumps. Then we start a diesel powered 600-cfm compressor that supplies air for the standby pump.

We resurrected an old air gage from the salvage bin and converted it to a relay device, sketch. It sounds an alarm and red warning light when the air pressure is in need of assistance from the auxiliary compressor.

A horn is mounted on the power pole next to the compressor shack and a 150-watt red bulb is added. When wind direction is wrong, or the roar of the pit equipment drowns out the tone, our crew can still "read" the red light from any reasonable distance. Who knows, maybe some day the overworked maintenance mechanic will rig up an automatic start-up device for the second compressor. Then we'd be all set.

P C ZIEMKE, *Clinton, Tenn.*

What would you have done?

City water for ice making in one plant was stored in two wooden tanks, each 7-ft dia by 15-ft 6-in. height. The 2½-in. thick wood sections forming the tanks were held in place by black steel hoops, 3-in. wide by 3/16-in. thick. Slightly more than 50% of the total area of each tank was exposed to direct sun rays for several hours during the day.

Temperature of city water delivered to storage tanks was 82 F, much higher than normal for city-water systems.

Because of sun's heating effect on the tanks, temperature of stored water increased an average of three-quarters of a degree during the period of sun's exposure. This isn't surprising since wood surfaces of tanks were 90 F, while temperature of steel bands (12 on each tank) was 100 F during hours of sun's exposure.

Rate of freezing to produce 100 tons of ice per day, plus amount dumped to sewer when core pumping, amounted to 8167 pounds of water per hour. All this water had to be raised three-quarters of a degree above temperature of entering city water.

I figured that to remove sensible heat from this amount of water, which results from temperature rise of three-quarters of a degree due to heat leakage through storage tanks, amounted to 306,250 Btu per hour during hours that sun's rays fell directly on tanks.

I solved problem by building a sun break to protect against solar heat. Then ambient temperature around the tanks dropped to 78 F, which of course eliminated losses due to heat gain from sun. One interesting fact in connection with this case: two storage tanks had been soaking up solar energy ever since they were installed 10 years before I built the sun break. Faced with the same problem, what would *you* have done?

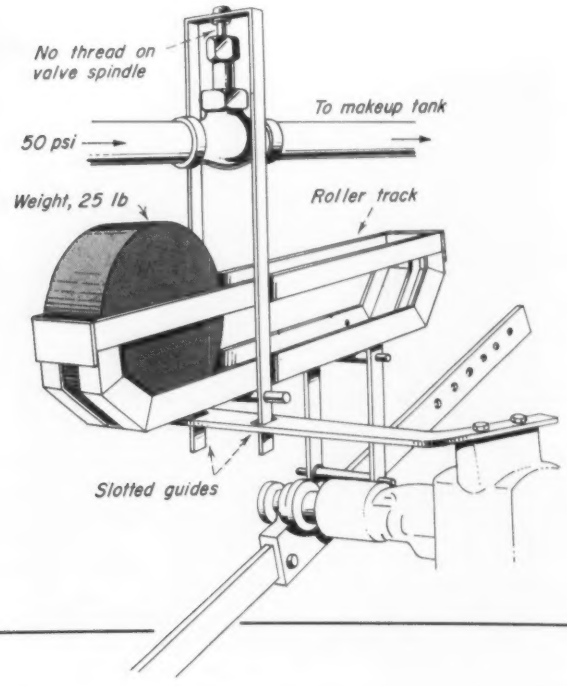
C T BAKER, *Atlanta, Ga.*

Use welding machine to defrost pipes quickly

Small exposed water pipes that freeze unexpectedly can be thawed with an electric welding machine. Just connect the leads to the ends of section to be defrosted. Heat generated by current in the pipe will do the rest.

R EWY, *San Francisco, Calif.*

Turn page for more Practical Ideas ►

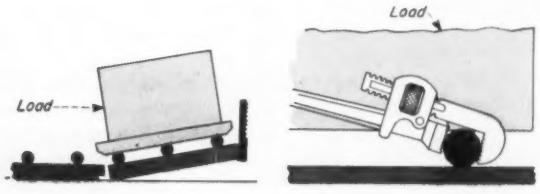


Rolling weight valve

We have a new plant, but even new meters slip at very low flow rates. We found our meter registering only a fraction of our softened dealkalized makeup.

Assuming meter to be accurate at a reasonable flow rate, I made up a float-operated two-position makeup valve, photo. Valve doesn't leak and has given no trouble since installation. Performance of dealkalizer and plant in general are now indicated more accurately. Rolling weight has probably been used before, but I have never seen one. How about you readers—have you used this before?

E G GARDINER, *Red Deer, Alberta*



Here's an easy way to move heavy loads

Skids and rollers provide one of the oldest and simplest methods of moving heavy loads. If you have a big load and a small crew, let gravity do most of the work. Get two track jacks and four timbers heavy enough to support the load without much sagging. Use jacks as shown in first sketch. Then you'll have a portable downhill track no matter where the load is headed. Chamfer skid edges so rollers slide under easily.

Larger the diameter of rollers (whether with level or tilted track) smaller the effort needed to move skid. But, more work is needed to bring larger rollers forward as load advances.

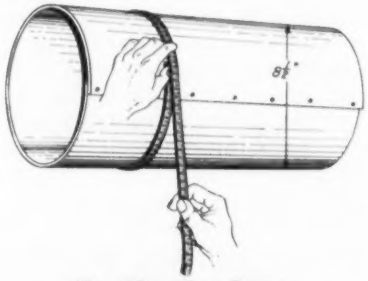
Good compromise is 4-in. pipe. If job gets stuck on track, use a pipe wrench to get it moving again, second sketch.

Rollers aren't always best bet when you're in a hurry. In a wartime rush job years ago, a rigger boss skidded big loads around on greased hardwood crating strips. Hoisting engines were used to slide loads full length of strips in less time than would have been necessary if rollers had been used.

H B MCDERMID, *Long Beach, Calif.*

Do you know...

that *Plant Operators' Manual* has over 1500 illustrations to show you how to do everything from inspecting boilers to making shrink fits?



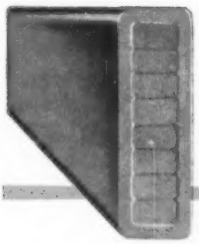
Centimeter tape saves figuring

Most plants have workshops where they can make some tubing out of sheet metal. When you know the diameter, but must figure the circumference to get sheet's size, use a measuring tape that's divided into centimeters. For every ⅛-in. diameter, take one centimeter circumference.

For example, your pipe diameter is 8½ in. which equals 68/8. Then circumference is 68 centimeters. The slight difference is negligible as it's only a few thousandth of an inch, which you can't measure anyway. This tape is easy to use and will help you to avoid making mistakes.

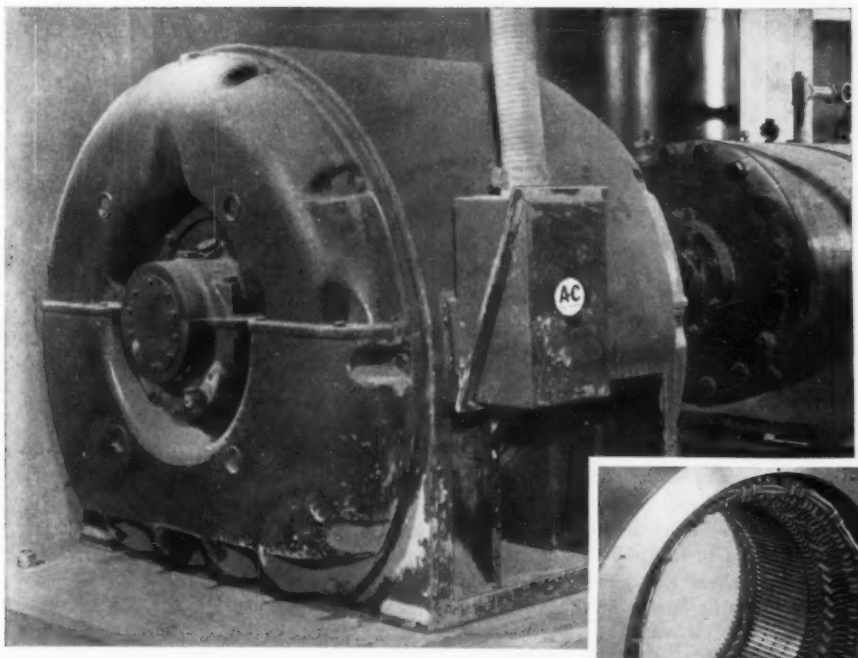
J JENTINK, *Alberta, Canada*

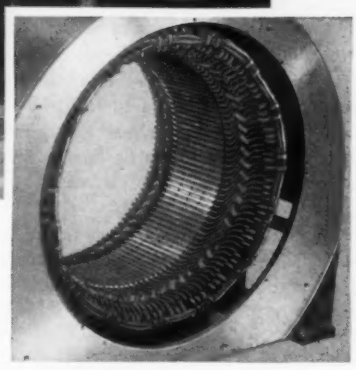
Turn page for more Practical Ideas ►



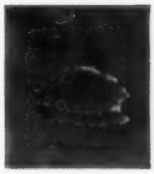
Super-Seal...

motor with void-free insulation



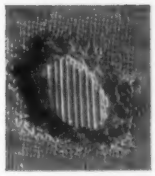


The motor that dust and dirt can't hurt



Silco-Flex Insulation

Polyester Mica Tape



Asphaltum Mica Tape

Note difference in abrasion! Insulation shown after sandblasting for one minute with 90-grit aluminum oxide and 100-psi air from distance of six inches.

REDUCE motor clean-up frequency and schedule this downtime at your convenience by using *Super-Seal* motors in areas where there's abrasive dust and clogging dirt. These motors —

Resist abrasion: Rubbery *Silco-Flex* insulation used in *Super-Seal* motors resists the cutting action of abrasive dust particles. Unlike conventional insulations, *Silco-Flex* insulation is flexible and resilient.

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Combined with void-free *Silco-Flex* insulation are integrated mechanical features that make this motor especially suited to your toughest applications.

Get details! Call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

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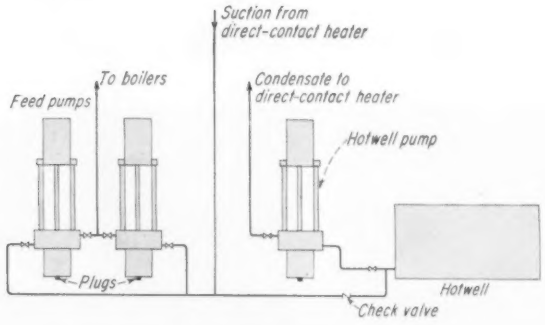


Why didn't the feed pump take water out of hotwell?

In one old-fashioned plant two reciprocating feed pumps were installed (one as a standby) together with a hotwell pump, a hotwell and a direct-contact feed heater.

During normal operation the hotwell pump took water out of the hotwell and pumped it to the dc heater. Feed pump took suction from the dc heater and discharged to the boiler. Pumps and hotwell were all at engine-room floor level. The dc heater was about 40 ft above the engine-room floor level.

We cut out the dc heater on week-ends. As very little exhaust steam was available during this period, the feed pump took direct suction from the hotwell.

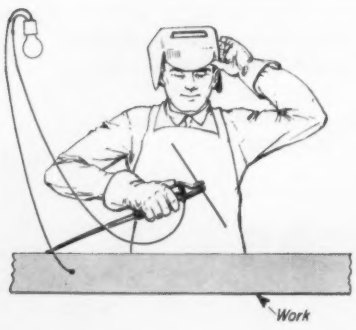
One late Friday afternoon we changed over to the hotwell. But the feed pump refused to take suction, although it had worked perfectly before we started the standby pump. We began overhauling the defective pump but couldn't find anything wrong. New water-end rings were installed and new packing, new gaskets, suction and discharge valves were ground in.

After completing the job, we started the pump on the hotwell. No soap—but it worked fine on the dc heater. Four or five times the pump was dismantled and put together again, but she still wouldn't pump. By then it became an unwritten law not to use that pump on the hotwell.

One day I dropped a wrench and had to go below the floor to get it. While looking around with a flashlight I found a little stream of water running from underneath the water cylinder of the pump. Looking closer, I found that a plug in the bottom of the cylinder had worked loose. That was the trouble we had been looking for.

As long as the pump took suction from the dc heater, there was enough head to prevent air from leaking into the cyinder. Taking suction from the hotwell provided almost no suction head. Besides, air could easily leak into cylinder through the loose plug.

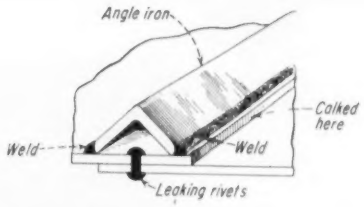
J DeHass, *Seattle, Wash.*



Emergency welding light

Here's a way to light up a dark tank for welding work when you have no 110-v power, see sketch at left. Use a pigtail socket and a 100-watt lamp, working light goes on the moment the stinger is raised.

T E Moyer, *Longview, Wash.*



Angle iron stops leaky rivets

A 100-ton ice-making plant contained two ancient 50-ton capacity freezing tanks. The 1¼-in. evaporating coils were between rows of cans. Tank was of riveted construction. During ice season, one tank developed a brine leak—bad enough to need a lot of new brine during summer operation.

Tank was shut down early in October and emptied of brine. Then it was thoroughly cleaned. Several loose rivets were found to be cause of leakage. Because all loose rivets were on tank's bottom it was impossible to replace leaking rivets with new ones.

First, metal along entire length of two rivet rows was cleaned of rust and dirt with stiff wire brushes. Then, entire length of joints were given a coat of red lead and linseed oil. Next, rivets were sealed off from the brine by welding a 2-in. angle iron in place, see sketch above.

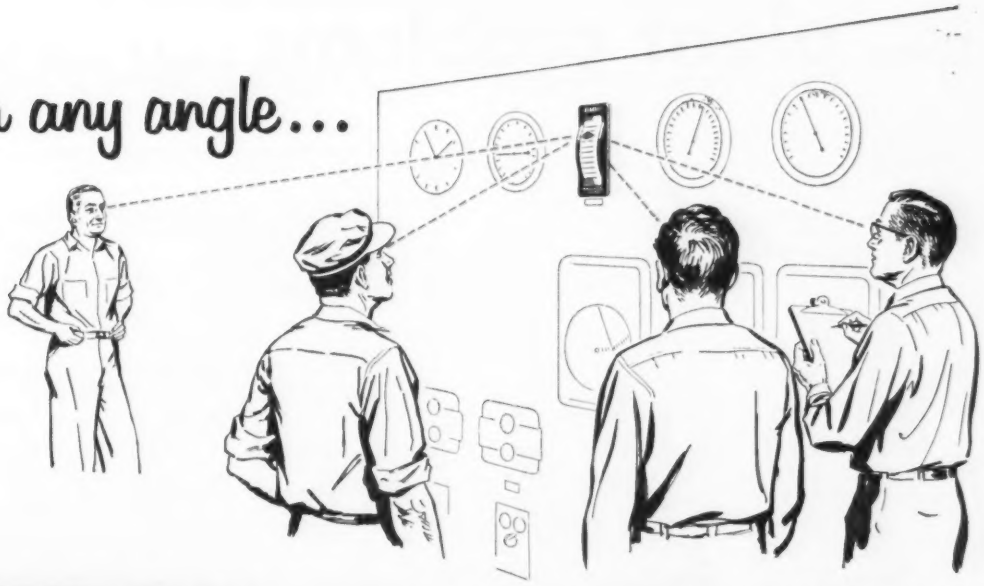
Several years have passed since this repair, but there has been no signs of leakage. There are still many riveted ice-freezing tanks in use. Some of them might develop leaks around the rivet heads. My method of repairing leaking bottom seams can be followed in most cases . . . but before tackling the job make sure you have a good man to do the welding just to be sure.

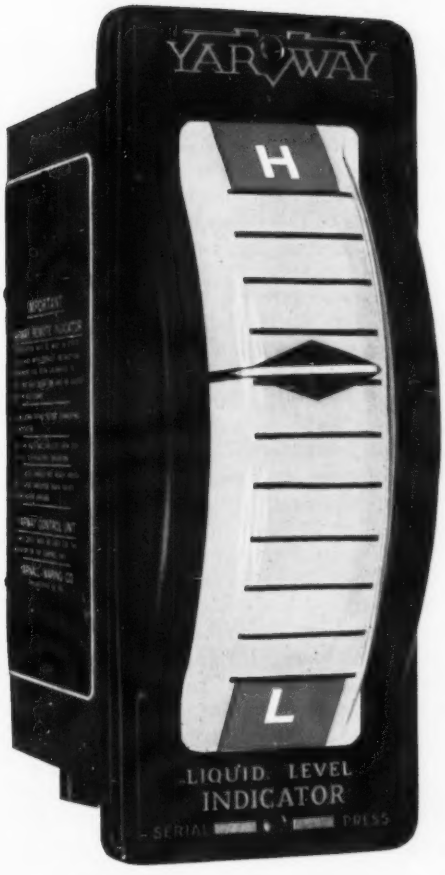
C T Baker, *Atlanta, Ga.*

My biggest boner

Please turn to page 192

from any angle...





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Readings are instant and accurate because the operating mechanism is actuated by the boiler water itself—by the pressure differential between a constant head and the varying head of water in the boiler drum. Pointer mechanism is never under pressure.

Yarway Remote Indicators are available fully compensated for every change in boiler temperature and pressure and they can be connected to Electronic Secondary Indicators or remote Hi-Lo Alarm Signals (lights or horns), located at any other point in the plant. Also available, Yarway Recorders working on same simple principle.

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Write for full details on Yarway Indicators for boilers, heaters and other applications. Bulletin WG-1824 tells all, shows typical hook-ups.

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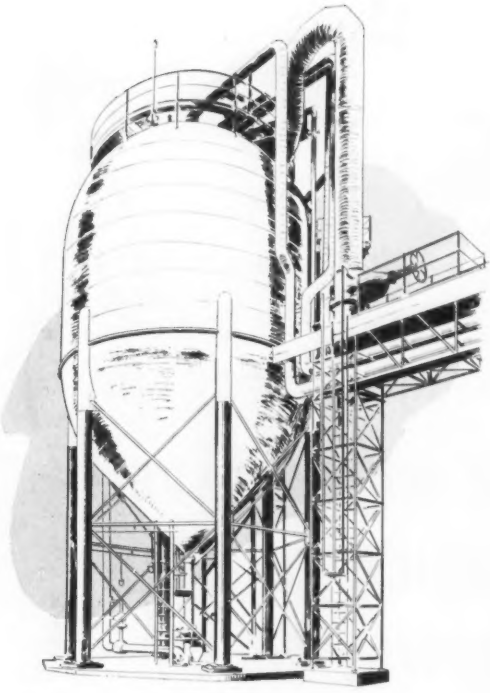


How should we modernize water-treating facilities?

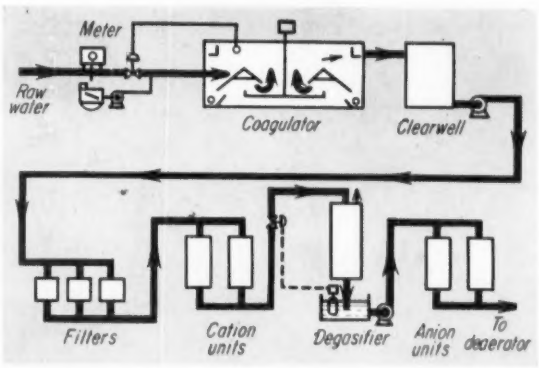
I'm power engineer for a large industrial plant that's updating its water-treatment facilities as part of a general power-services modernization. After considering our steam and electrical load, we've decided to add a 900-psi 750-F 150,000-lb-per-hr boiler and an automatic-extraction high-pressure turbine-generator. We generate our own byproduct power, but use local utility for standby.

Our raw-water analysis runs about like this:

Ca as $CaCO_3$	80 ppm	Cl as $CaCO_3$	3 ppm
Mg as $CaCO_3$	45 ppm	SO_4 as $CaCO_3$	8 ppm
Na as $CaCO_3$	8 ppm	Silica as SiO_2	5 ppm
HCO_3 as $CaCO_3$	122 ppm	CO_2 as CO_2	5 ppm
CO_3 as $CaCO_3$	0 ppm	pH	7.7
OH as $CaCO_3$	0 ppm	Turbidity	40 ppm

We are replacing a hot-lime-soda water-treating plant built during the early thirties. Because of process contamination we average about 50% makeup water. Condensate returns account for the balance. Older boilers include six 250-psi 25,000-lb-per-hr units. I would like to get opinions from readers on the type of water-treating equipment they'd consider most practical for our new plant.—*FRH, January* POWER

The solutions



Demineralizing is one of three methods

It would help to know: (1) capacity of existing treating plant (2) physical size of sedimentation tank and filters (3) whether or not the softener is the deaerating type (4) present operating results.

FRH's raw water probably comes from a surface supply. But we don't know how much the turbidity varies from 40 ppm. Does the supply contain any sewage or trade wastes? Answers to these questions will influence the type of treatment selected. But, as I see it, there are three possible recommendations:

(1) Segregate condensate for the new high-pressure boiler. If makeup to the 900-psig boiler is 50% or 75,000 lb per hr, it may be possible to collect the best part of this condensate and feed it to the new high-pressure boiler. Analyze condensate for turbidity, oil and silica. Then, enlarge existing hot-process plant for larger amount of makeup to low-pressure boilers.

(2) Another solution is to enlarge and modernize the existing hot-process plant. This means adding a second sedimentation tank, more filters and following with new hot-zeolite units. Water from this plant will be suitable for all their boilers, including the new one. Here's how raw and treated analyses compare:

Hardness is reduced from 125 to 0-2 ppm. Alkalinity drops from 122 to 40 ppm. Turbidity is completely removed and the silica lowered from 5 to less than 1 ppm.

Chemicals needed and their approximate costs are:

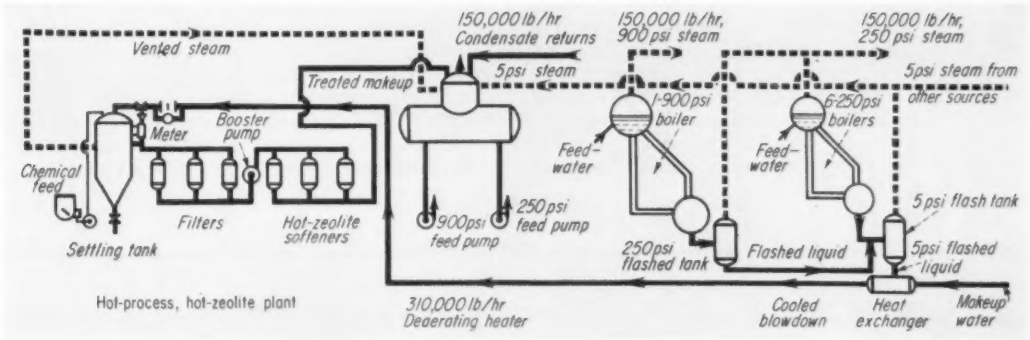
Lime hydrate	1.0 lb @ 1.5¢ = 1.5¢
Soda ash	0.2 lb @ 3.0¢ = 0.6¢
Activated Magnesia	0.2 lb @10.0¢ = 2.0¢
Salt for zeolite	0.8 lb @ 1.5¢ = 1.2¢
Total cost per thousand gallons	= 5.3¢

About 10 to 15 ppm silica can be tolerated in the 900-psig concentrated boiler water without causing turbine deposits. With 1 ppm silica entering the boiler, it can concentrate 10 to 15 times. This level is maintained by continuous boiler blowoff of 6 to 10% using a flash tank. The resulting flashed steam goes to the deaerator.

(3) Demineralizing is the third possibility. But a

...Here's how Power readers would tackle them

ROBERT MARKS, Assistant Editor



Hot-process, hot-zeolite plant can produce good treated water for 900-psi boiler

FRH's boiler water should meet ABMA standards. At 900 psig the upper limits are 1500 ppm total dissolved solids, 30 ppm silica and 300 ppm alkalinity. For the 250-psig boiler, these limits are 3200 ppm total dissolved solids, 100 ppm silica and 640 ppm alkalinity.

Treatment for the 900-psig boiler must: (1) eliminate hardness (2) reduce silica to avoid turbine-blade deposit (3) reduce alkalinity to minimize return-line corrosion (4) reduce total dissolved solids to keep boiler blowdown at a minimum. It's also desirable to remove oxygen from both makeup and condensate.

There are a variety of treatment methods available to meet these objectives. Demineralizing will completely remove all the troublesome constituents. But, in this case, the expense isn't warranted by the relatively low boiler operating pressures.

Hot-process, hot-zeolite setup, above, does attain most of our treatment objectives. Turbidity, hardness, alkalinity and silica are reduced. Since sulfate and chloride content is very low, treated alkalinity will exceed the recommended 20% of total dissolved solids. But this can be adjusted by feeding sodium sulfate.

Hydrated dolomitic lime reduces hardness and alkalinity to about 20 ppm and silica to 1 ppm or less. Calcium carbonates and magnesium hydrates formed carry down any turbidity present. Effluent is then filtered and the residual hardness removed in the hot-zeolite units.

Boiler blowdown, based on total evaporation from the 900-psi boiler, is nominal. It runs about 1.7% with a 50-50 mixture of condensate and treated makeup. If sodium sulfate is used, this figure becomes 4.1%. The 250-psi boilers need only about half this blowdown since higher boiler-water concentrations are allowed.

With this feedwater setup, no changes will be needed if and when the older 250-psi boilers are replaced by another 900-psi boiler. Treating costs are low since only 1.75 lb hydrated lime is used per 1000 gal treated makeup. If sodium sulfate is used, 0.83 lb per 1000 gal treated makeup will do the trick.

A C EMBSHOFF, *Tucson, Ariz.*

---

coagulation and filtration plant is needed to (a) clarify the raw water (b) help avoid fouling of the exchange resins. Demineralized-water total dissolved solids will be less than 5 ppm and the silica under 0.1 ppm. Continuous blowoff will then be only 1% of makeup.

Chemical operating cost for demineralizing is:

Alum	0.2 lb @ 3.0¢ = 0.6¢
Acid	2.0 lb @ 2.0¢ = 4.0¢
Caustic soda	1.0 lb @ 5.0¢ = 5.0¢
Total cost per thousand gallons	= 9.6¢

This is about double hot-lime zeolite; and cost allowance must still be made for anion-resin replacement.

Relative investment for each method depends on how much of the old equipment is used. Since *FRH's* surface supply must be clarified before demineralizing, investment for this treatment will be considerably greater than hot process. Demineralized water is highest in quality. But hot-lime zeolite will do the job with lower operating cost and initial investment. And it handles moderately turbid waters without preclarification.

S B APPLEBAUM, *Philadelphia, Pa.*

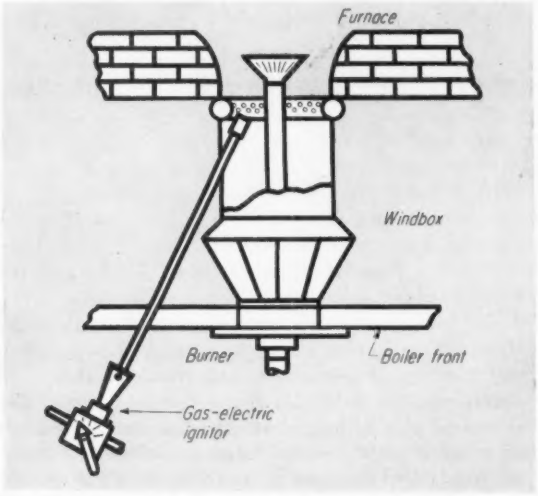
Turn page for info on lighting off boilers ▶

What's the best way to light off boilers?

In our plant we have several watertube boilers which are fired with oil. Three are combination gas and oil. In lighting off these boilers it has been customary to use a plant-made lighting torch, prepared from a length of rod. Head of the rod was made by winding several layers of asbestos rope around the end and securing it with iron wire. The torch was then dipped in kerosene and used to light the burners in each boiler. This works fine for a short time, but the torch soon becomes ragged and useless.

Perhaps POWER readers know of a better way to perform this operation—possibly some solid substance capable of standing up under hard use, yet porous enough to absorb kerosene and stay lit under momentary blasts of forced draft. Or, would an entirely different method be better?—*LW, January* POWER

The solutions



Why not try a gas-electric ignitor?

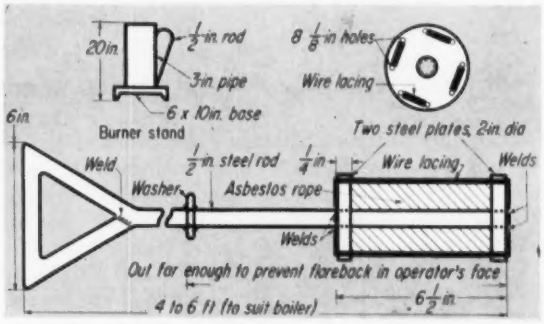
At our plant we have two 425,000-lb-per-hr oil-gas-fired boilers. When the plant was first put into operation we used a torch similar to the one described by *LW*. There was always the possibility of the torch going out from blasts of forced draft and it didn't hold up with constant use. We installed gas-electric ignitors, above, and found them dependable, efficient and safe. *LW* should stop using a torch and consider gas-electric ignitors.

F W HOYER, *San Gabriel, Calif.*

Automatic ignition is your best bet

Best way to light off a boiler is by automatic ignition. *LW* has gas fuel in the boiler room so why not use a gas pilot flame to ignite the oil-fired boilers? Lighting boilers by hand is a relatively dangerous, labor-consuming task. *LW* should try to convince management that money used to convert to automatic ignition is money well spent.

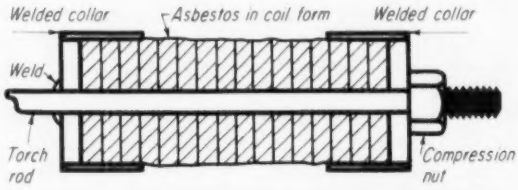
P A DETHLOFF, *Chicago, Ill.*



This torch has given 5-yr service

Burner lighter, above, may be the answer to *LW's* problem. We have used three of these for the last five years. They have given good service and still have the same wrapping. Each one is kept in its own stand with about six inches of kerosene ready for use at any time.

J D RILEY, *Glendale, Calif.*



Our design doesn't get ragged

Torch, above, will give trouble-free service. Base is welded to the torch rod. Collar, made from pipe, is welded to the base. Top is constructed in the same way except that it's free to move on the rod. Compression nut on threaded end keeps asbestos under pressure. Periodic adjustment prevents torch from getting ragged.

M P FEURING, *Country Club Hills, Mo.*

STEEL FORGINGS by MESTA

for HIGH PRESSURE and HIGH TEMPERATURE PIPING

custom made to your mechanical and metallurgical specifications

PIPE

TEES

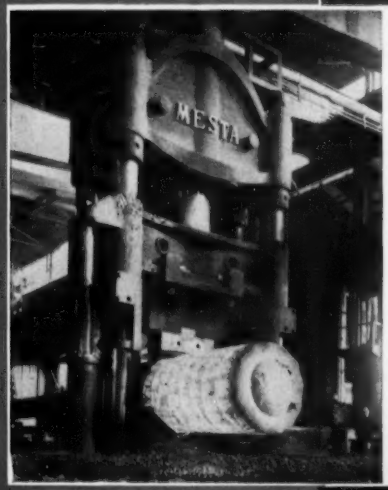
Y'S

VALVE BODIES

LATERALS

CROSSES

ELLS



● Forging High Pressure—High Temperature Pipe on a MESTA 6000 Ton Hydraulic Press in one of the MESTA Forging Shops.

Chrome Molybdenum Alloy Steel Pipe forged, machined, rigidly inspected and tested to comply with customer and code specifications. MESTA Forged Piping provides confident service in High Pressure and High Temperature Piping Systems.

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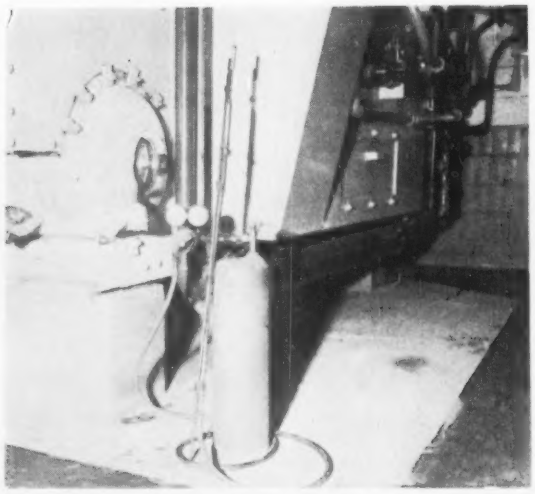
MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

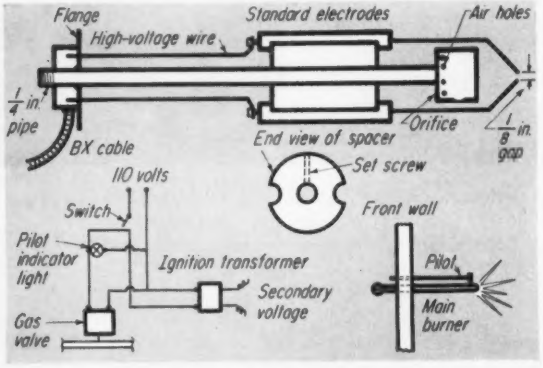
More **plant problems** Begins on page 136



Gas tank, welding torch is one answer

Our plant has four watertube boilers with combination oil and gas burners. We use the gas tank and welding torch, above, to light off the gas-burner pilots. The gas then ignites the oil burner. But we can also light the oil burner directly. We regulate torch flame at the tank rather than at the end of the torch itself. This prevents accidental opening or closing of the valve when the torch is inserted in the light-off port.

T A MUELLERLEILE, *Owatonna, Minn.*

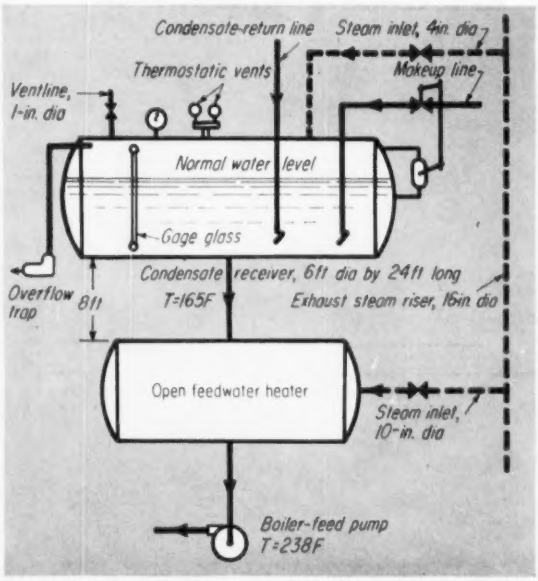


No light-off problem here

We rigged up the pilot burner, above, using bottled gas. The ¼-in. pipe was welded closed at one end and drilled with air holes. Then, a drilled sheet-metal nozzle was brazed on this end. The electrodes were clamped to an aluminum spacer with plumber's tape. We then welded the flange on the other end and attached a junction box. Wiring diagram is shown above. The gas valve was salvaged from a unit heater. Not once did the boiler fail to light off properly. It cured a bad case of wincing every time a boiler was lighted off.

F E ZEIGELMANN, *Fullerton, Calif.*

Your April problems



What's wrong with this heater setup?

Above system operates at 9 psi during winter months and 5 psi in summer with less than 1 psi fluctuation. In wintertime, condensate receiver pressure can drop enough to stop flow to the open heater below. This may happen three or four times a day. But there are also periods of two to three weeks when the system seems to operate smoothly. What can we do to avoid this trouble? Do POWER readers have a better overall arrangement to suggest?—*CZ*

Should we switch from jam type packing to mechanical seals?

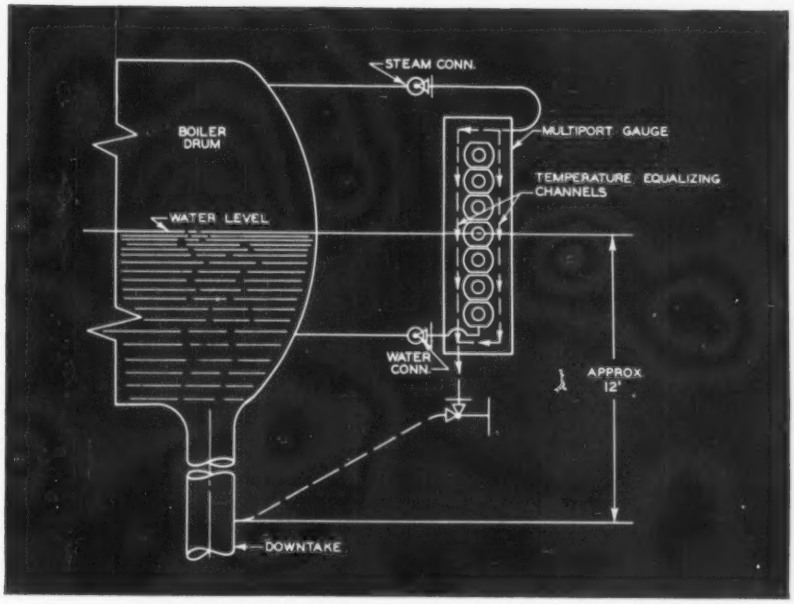
We have three barrel type high-pressure boiler-feed pumps. Suction pressure of these pumps is 35 psi, discharge 1400 psi. Suction temperature is 250 F and shaft speed is 3600 rpm.

We're thinking about replacing the jam type packing in these pumps with the newer mechanical seals. However, I'm worried about shutdown if the mechanical seal fails. With our present setup, we can always add another ring of jam type packing. But, shaft sleeve wear is already excessive, giving us maintenance problems.

Before making any change, I'd like to know what experience POWER readers have had with similar jobs.—*MJD*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

ANOTHER NEW GAUGE DEVELOPMENT BY Diamond



Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

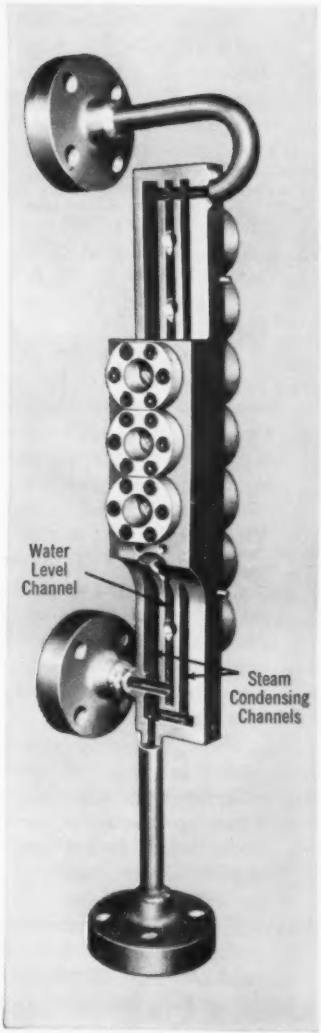
The need for correction of inherent gauge error at high operating pressures is well recognized, but heretofore no satisfactory simple answer has been found. Now, Diamond has developed the Temperature-Equalizing Multi-Port Gauge* to reduce the error in gauge level reading by a simple and fully reliable means.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150 for further information.

*Patent Applied For

8031



Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED—Windsor, Ontario

Your page for comment

BOB BELLAS, Assistant Editor

Electrical discharge

Foreword of your article "Electrical distribution," March 1958, p 79, lists AIEE, EEI and equipment builders in that order, but the article starts out with EEI activities. It sort of throws one for a loss to have the order of presentation changed.

Since AIEE is an organization of both EEI and manufacturers (and many others), I'd like to see the Industrial Power Systems Committee in the lead discussions. Also IPS's program is an established fact, yet you infer otherwise. And it wasn't "last month," but *months* ago that IPS "gave its blessing" to the program.

How about giving the "Red Book" a little publicity by using its right name: *Electrical Power Distribution for Industrial Plants*, AIEE publication No. 952? After all, the main purpose of the course is to get the "Red Book" known.

RAY ERWIN, *Dept of Water & Power, Los Angeles, Calif.*

. . . I think your article overemphasizes results being obtained by the propaganda of some of the major electrical equipment manufacturers on power distribution.

As chairman of the subcommittee on Industrial Power Distribution for the AIEE, I know we've been the acting force behind the study groups which the institute has been conducting all over the country. They've been very successful in that they recognize the main reason why industrial plant power systems are as bad as indicated by Westinghouse Vice-President Monteith.

From my past experience, both in selling power distribution equipment and with electrical engineers in industry, I find that the principal reason for *bad* power distribution is this: *good* power distribution benefits aren't understood by the men who have to approve funds for getting the distribution equipment.

Major equipment manufacturers have been appealing to plant electrical engineers, who are probably the world's worst salesmen. These manufacturers are amazed when the wonderful plans and specifications (recommended to the plant electrical engineers) are reduced to a vanishing point when the orders come in.

Four basic arguments must be answered before any power system is modernized: (1) Why is it important? (2) What will a modern power system do for the plant? (3) How do we know what we need? (4) How are the components evaluated?

Unless the answers are in plain language that the plant manager can understand, there's not much hope for any plant to improve power distribution. For this reason, AIEE study groups have carefully refrained from letting any *one* electrical manufacturer monopolize the thinking in our study groups on power distribution. The major manufacturers will gladly conduct such study groups and furnish all necessary speakers, films, etc. But, we feel that our success with our audience who, after all, are the ones to be convinced, is due to a lot of ideas by a lot of companies and presented in plain-to-understand language. For example, here in Newark we had a 50-man audience, of which only eight were electrical engineers. Balance were plant managers, production managers, mechanical engineers, safety directors, etc—people who are not as a rule even invited to the so-called power courses. Importance of the meeting was proved by the 90 to 95% attendance at each of the ten sessions. I've since opened a new study group in Cincinnati, POWER, March, 1958, p. 80. Opening night drew 165, of which only 40 were AIEE members.

It's fine for large electrical manufacturing companies to moan about inadequate power distribution. But until they remove the air of secrecy concerning what is good and what is bad, industrial plants as a whole will listen politely—then let it go out the other ear. Power distribution in industrial plants is like the weather; everybody talks about it but nobody does anything about it.

J W ST. ANDRE, *Chief Electrical Engineer*
Kaiser Aluminum & Chemical Corp, Newark, Ohio

How about some facts and figures?

Your article, March 1958, pp 87-89, is interesting and shows a new approach to the problem of cleaning and purifying low-grade fuel oils for diesel use. Unfortunately, you don't furnish any data that would (1) demonstrate results that can be obtained by the chemical wash treatment or (2) show how much the treated oil will improve engine performance. Some facts and figures would be of interest to diesel-plant operators.

Another important item to any diesel-plant operator is cost of equipment installed. Also, some information as to operating costs, including cost of electrical power, of chemicals, and of operating and maintenance labor would have added value to your story.

The authors indicate that one-stage purification only is necessary for preparing Navy Special Fuel Oil for use in the engines. However, they indicate a need for two-stage centrifuging and chemical wash for the heavier residuals. It would be nice to know what oil characteristics govern an operator's decision as to when to use one-stage purification or change over to the two- (*Continued on page* 212)

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

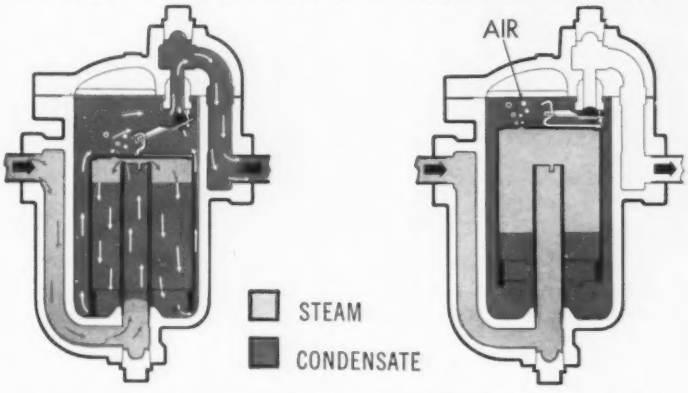
You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8124 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

1

2

(1) Utility wiring is included in walls. Wiring, telephone lines are under post caps. (2) Post caps are installed on partition.

3

4

(3) Shims and floor stampings provide a straight, rigid wall. (4) Corner clips hold corner post, giving look of modern wall

How to

put up movable walls

Maintenance office, photo below, in generating building of Cleveland Electric Illuminating Co's Eastlake plant, is made of movable metal walls. In case firm should decide to increase the plant's output by installing additional generators, this office, located in the turbine-generator area, can be easily and quickly moved to another location.

Problems were need for sound control, insulating from heat, protection from coal dust and ease of maintenance. Partitions are carefully engineered with lower portion of all panels containing access openings to rear of controls. They are insulated with rockwool and provide a barrier which reduces sound transmission far below the level of a "fixed" or plaster and lath wall. Because heat-radiating boilers are nearby the new office is air conditioned.

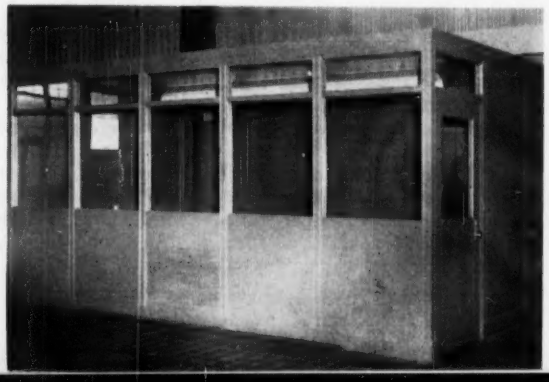
Study shows that movable walls cost less to install, require less upkeep and are cheaper to move or enlarge. Walls shown are tied together with post caps that are tapped into place.

—Courtesy, E F Hauserman Co, Cleveland, Ohio

5

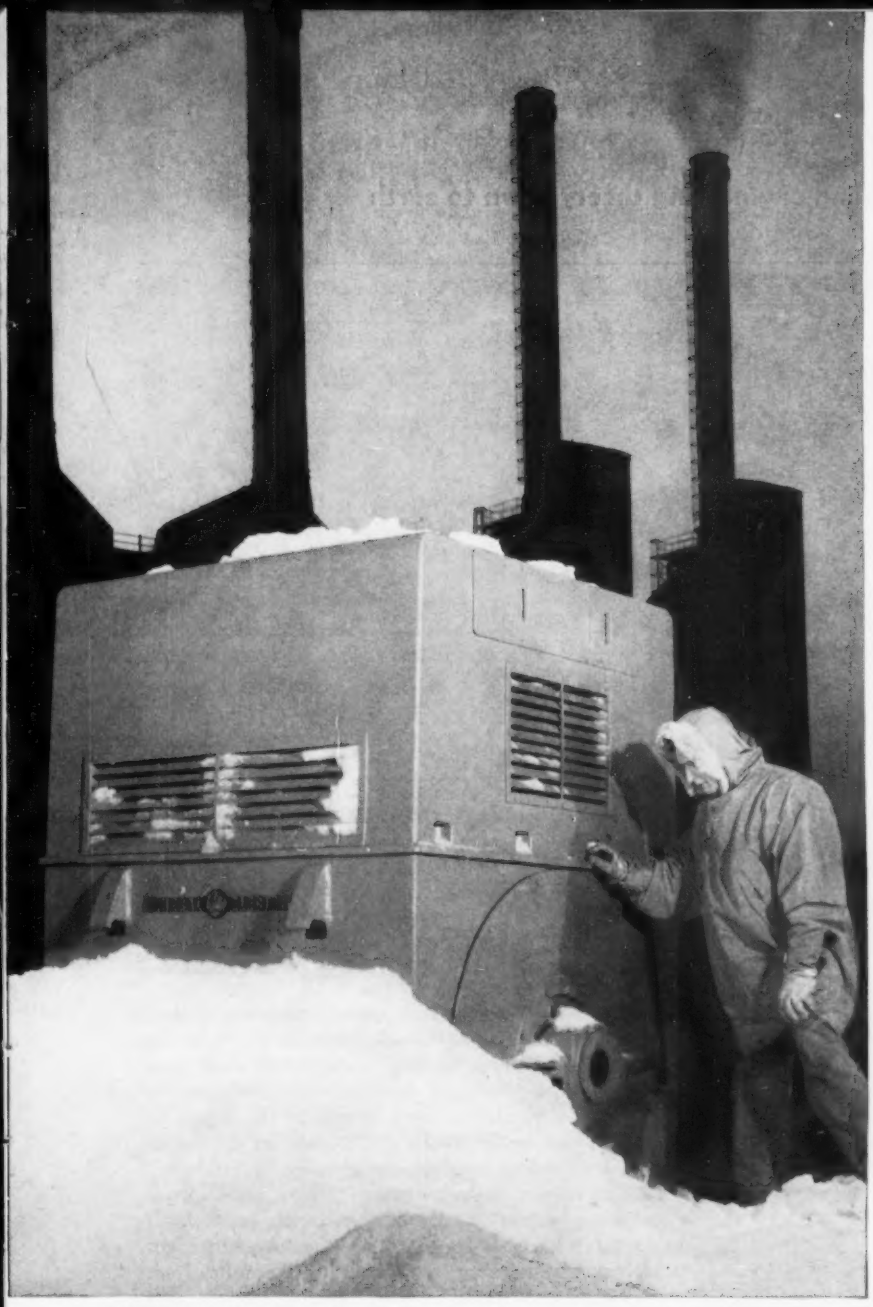
6

(5) Special panel has switch, is installed over rockwool lagging. (6) Corner panel is installed, gives tight ceiling-to-floor fit



MAINTENANCE OFFICE is complete; but can be moved, expanded

→



General Electric Announces...

ALL-NEW WEATHER PROTECTED MOTOR

Wind, rain, snow, and even hurricanes, are little hazard to General Electric's *new* Weather Protected Motor—first major redesign of weather protected motors since their 1948 introduction.

General Electric's new design offers you the best outdoor protected drive available for your motor needs. Just install it, and don't worry about it when adverse weather strikes.

ALL-WEATHER PROTECTION built in the new design is the result of a unique top intake and exhaust ventilating system which utilizes a labyrinth baffling system to remove contaminants before air reaches motor interior. Incoming air is required to make a series of right-angle turns and reductions in velocity before entering motor interior.

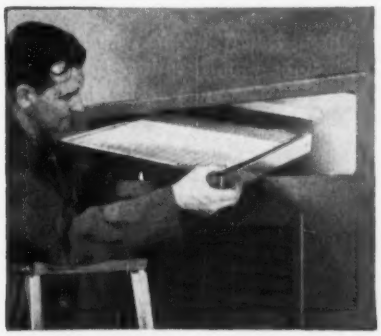
The new design, developed in G.E.'s Medium AC Motor and Generator Dept. to meet or exceed NEMA Type II definition, has passed a series of "hurricane tests," during which tons of water were hurled on the motor at wind velocities up to 100 mph. At completion of tests no moisture had entered the motor interior. Danger of pressure build-ups during severe storms is reduced by special "blow-through" passages for high velocity winds.

FOR MORE INFORMATION on this modern motor design, consult your nearby G-E Apparatus Sales Office or write to Medium AC Motor & Generator Dept., Section 882-7, General Electric Co., Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

BETTER PROTECTED AIR OPENINGS—"High up" air intake passages of new G-E motor prevent snow, trash, dust or dirt from being drawn into motor. Passages do not clog. Side intake and end exhaust prevent recirculation, allowing side-by-side mounting with minimum spacing.



TOP ACCESSIBILITY—Air passages in top section are completely accessible through nine openings. Filter installation, inspection or replacement is fast and easy.

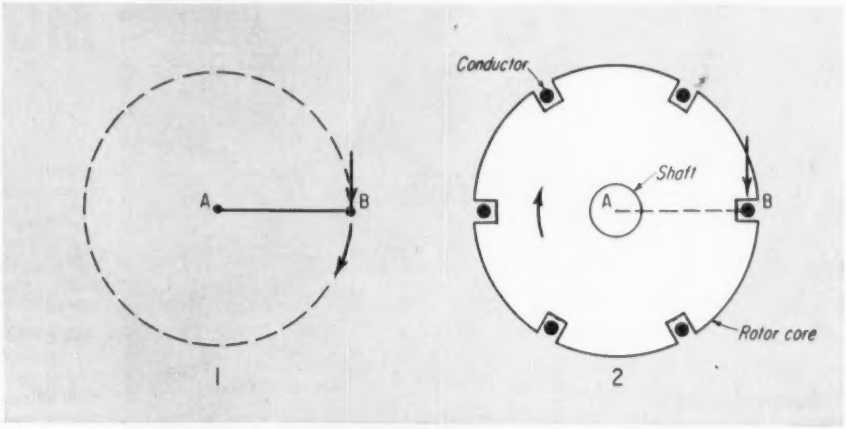
EFFECTIVE DIRT REMOVAL—Ventilating system of new Weather Protected Motor prevents dirt, moisture and other contaminants from entering motor interior.

SIMPLIFIED MAINTENANCE—Removable, lightweight end shield permits complete accessibility to motor interior and bearings without disturbing alignment.

Basics . . . bringing engineering theory down to earth

NORMAN PEACH, Assistant Editor

Electricity: 20



TORQUE is developed at motor shaft by force on rotor periphery

Torque, horsepower and rpm

Torque is the twist, or tendency to turn, of an object. The object may actually rotate as a result of the applied torque, or it may not move because it is held too tightly in place. In either case there is torque. Torque is the product of the force applied at a point on the object times the distance from the point of application to the center of rotation. In sketch 1, consider *A-B* to represent a rigid bar capable of rotating about point *A*. If *A-B* is 2-ft long, and the downward force at *B* is 10 lb, the torque is 20 *pounds-feet*. In exceptionally small machines torque is expressed in ounce-inches.

The rotor or armature of sketch 2 is slotted to hold the conductors. Flux produced by current in these conductors reacts with the motor field (*Basics* No. 9 and 18) to apply a force on the rotor at *B*. This force acting through the distance *A-B* produces torque at *A* and causes the shaft to rotate. Simultaneously, torque is produced by the conductors in the other slots. These torques add up to give the motor torque.

When torque produces rotation, power is developed. Relation between horsepower and torque is:

$$hp = \frac{6.28 \times rpm \times torque}{33{,}000} = \frac{rpm \times torque}{5255}$$

Torque is the factor that produces stress on the mechanical parts of the motor; therefore a slow-speed motor will be physically larger than a high-speed motor of the same horsepower. A 1-hp motor at 1800 rpm is twice the size of a 1-hp motor at 3600 rpm. This can be seen from the formula; as rpm goes down, torque must go up in order to maintain the same horsepower rating.

We've been talking about *rated torque*, the torque a motor produces when running normally at rated rpm and hp. Torque produced at other times isn't easy to calculate. It depends on many factors in the design of the motor, and we've usually got to rely on the manufacturer's ratings or conduct a test on the motor.

Starting torque or *locked rotor torque* is the torque a motor produces at standstill when trying to start. If the motor actually starts to rotate, the torque changes rapidly as speed increases. Preventing the rotor from turning gives us a measure of the starting torque available to accelerate a given load which the motor is to drive.

Maximum torque is developed in some motors at standstill, but in other designs maximum torque is developed at some particular speed.

Breakdown torque is the greatest torque which a motor will develop just before rapidly losing speed. This refers to a condition where the motor has been running at normal speed and hp, and then the load is increased, overloading the motor. As this happens, the speed begins to drop off a little and the torque goes up more rapidly in order to develop the extra horsepower. If the load continues to increase, however, a point is reached where the motor can no longer produce more torque. Both speed and torque fall off rapidly and the motor stalls. Except in the case of specially designed motors, the motor will burn out if subjected to overloads this severe for more than a few minutes. Always be sure that motor and load torques have matching characteristics.

ANOTHER NEW LESLIE PRODUCT

ADJUSTABLE PROPORTIONAL BAND Floatless LIQUID LEVEL CONTROL

...with adjustable level ranges up to 0-200"

Here is a new differential pressure-type liquid level control pilot that combines the wide adjustable level ranges in the table shown below with a 2-20" or 7-25" adjustable proportional band.

ADJUSTABLE LEVEL RANGE — INCHES	ADJUSTABLE PROPORTIONAL BAND (INCHES, H_2O)	CONTROL PILOT TYPE
0-40 or 0-87	2-20	LAP
0-30 or 0-91	2-20	LABP
0-200	7-25	LAUP

Maximum Static Pressure — 300 psi

One Knob — Easy Adjustment

A single knob adjustment quickly sets the proportional band where you want it, even while the system is in operation. The liquid level is maintained constantly within that band until you re-set the control pilot for new conditions.

Applications

Leslie-Level-Matic Control Pilots are used in either open or pressurized vessels to control the level of virtually any liquid including water, gasoline, oil and chemical solutions. The new control pilot is particularly useful to maintain constant levels where there are high flow rates through vessels with small cross sectional areas.

Float Cages Eliminated

There are no floats or cages needed for Leslie-Level-Matic Control Pilots, and no torque tube seals, stuffing boxes, or thermohydraulic systems. All of the primary control elements are in one place and may be installed with a fraction of the effort and cost required for displacement-type controllers.

Vibration-Proof, Dependable

All of the dependability factors for which Leslie products are so well-known are incorporated in this new control pilot, as well. Rugged, accurate, stable — it is unaffected by normal vibration or turbulence.

More Information

Send for Engineering Data Sheet describing this new Control Pilot and outlining its principle of operation.

Knob and indicator-type proportional band adjustment permits setting in a matter of seconds.

LESLIE REGULATORS and CONTROLLERS

674

LESLIE CO., 235 Grant Avenue, Lyndhurst, New Jersey

"After lunch we walked over to the new diesel. I told Carter to have his men get busy with wheelbarrows," declared Marmy.

Marmy's hydraulic jack

With that 24-page nondestructive-testing job out of my hair in March, I thought Marmy's comments on the subject might be interesting. So I climbed the dingy stairs to his office above O'Houlihan's Machine Shop & Engine Works to find out.

Pausing for a second before the brightly painted red door, I read the lettering on the glazed glass:

Marmaduke Surfaceblow, Esquire
Consulting Engineer
Phone, Hell's Kitchen 2-1876

No question about the old gent being in. The babble of gravelly voices from inside and the acrid tobacco smoke issuing from around the door and keyhole left no doubt about it. Next step was to muster enough courage to barge into that goat's nest.

Grabbing the door knob firmly and taking a deep breath of fresh air while I had the chance, I stepped inside. With a blast of smoke choking off my fresh-air supply, I started coughing violently. Through tear-dimmed eyes I could see Marmy's huge figure behind his roll-top desk.

The old pot-bellied stove glowed red and the coffee pot simmered away, sending its strong aroma to mix with the tobacco smoke. Soon as I stopped coughing I got to wondering what kind of orsat readings one could get in that room of No. 4 Ringelmann smoke.

A half-dozen tough-looking waterfront characters were seated on the ship's settee along the wall. Everyone seemed to be either slurping coffee, arguing or smoking. Only the old consulting engineer was aloof and tending to his business. He was examining blueprints through his silver-rimmed reading spectacles, paying no attention to the noise around him.

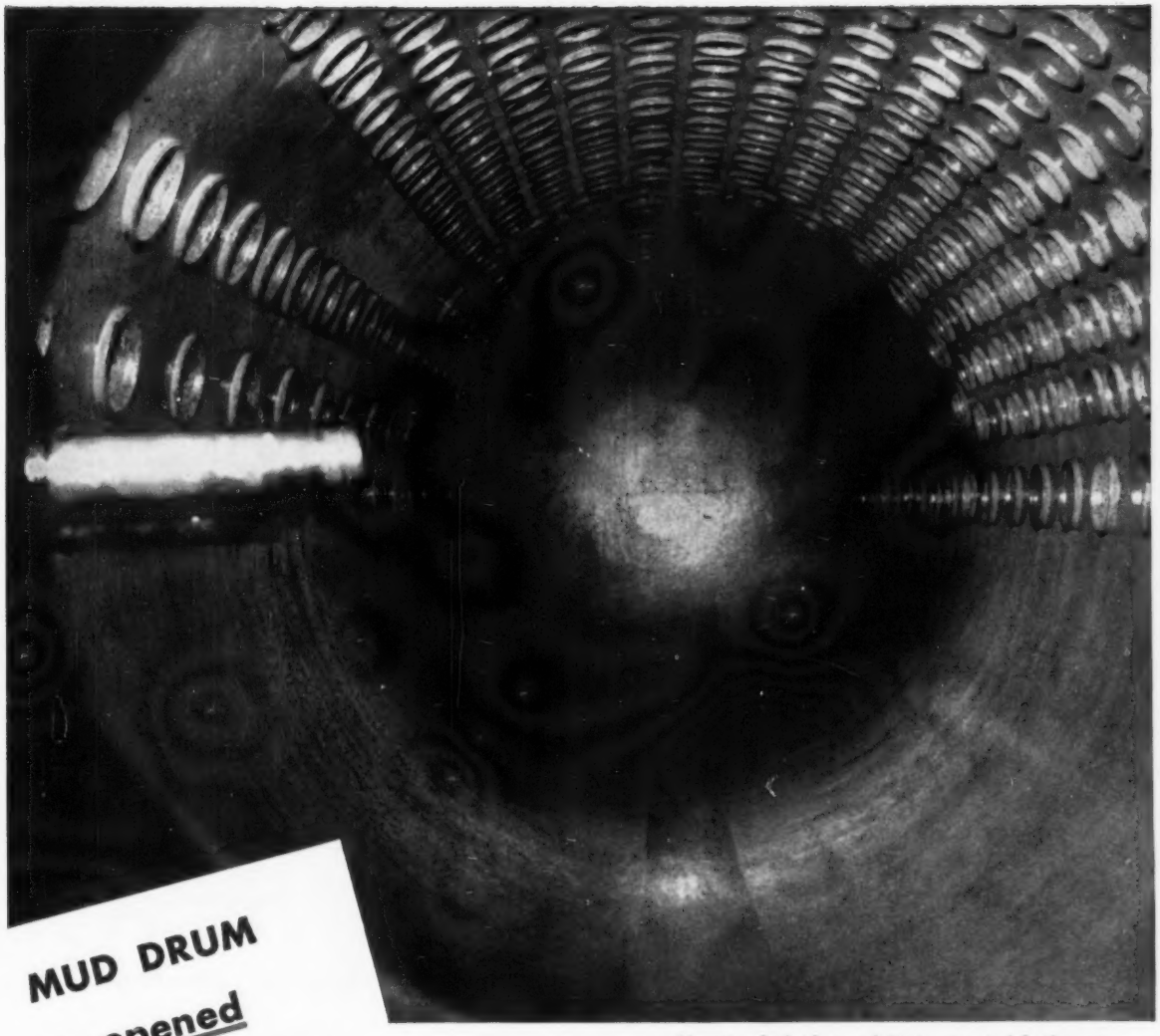
As usual, no one paid me the least bit of attention. So I stepped up to the roll-top desk and placed our March issue before Marmy and waited. He glanced quickly at the cover, then roared "BILGEWATER on nondestructive testing. I'll tell you armchair engineers about the time I lowered a 5-ton diesel onto its foundation; and all I used was my head."

With that, he dropped his blueprint, hoisted his No. 16 canal boats up on his ancient desk, puffed furiously on the rope yarn sticking out of his face, and settled back into his swivel chair. Giving his battered gray bowler a starboard list, he blasted away in his foghorn voice.

"Back in the winter of 1933 I was chief engineer on the Mississippi River packet boat *Mary Ann*, running between St. Louis and New Orleans.

"Soon as we tied up at Vicksburgh one cool January morning, I crossed the wharf to see my old shipmate Jed Karper, owner of the Steamboat Bar. Jed and I had sailed on the *USS Dale*, first of the Navy 4-piper flush-deck destroyers, back in 1918.

"Jed was at the bar, talking to two solid looking citizens. One was Niel Carter, owner of the Vicksburgh Ice & Cold Storage Co. Other was Pud Garaway of the Garaway Trucking Co. Sounded like they were having a hot argument. (*Continued on p* 182)



MUD DRUM
as opened
after one year
on line
with
THE *Nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

NATIONAL ALUMINATE CORPORATION
Telephone: POrtsmouth 7-7240
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*®
SYSTEM . . . Serving Industry through Practical Applied Science

Reader service section

Start with these quick samples . . .

Spring is here . . .

which means it's spring-cleaning time again. Cleaning, by the way, costs American industry a cool billion per year, and still that dusty old air pollution is liable to crop up in pea-soup smogs, and summonses from the inspector. For one way to stretch your dust-control dollar, check . . .

Reports from the field, p 152

Crocuses are blooming . . .

flags are flying, the Vernal Equinox has passed, and we've come up with abstracts of the latest technical papers to save you time for those springtime chores. By reading these quick digests you can find out briefly what's going on in the power field; then send for the full report if your curiosity is whetted . . .

Technical briefs, p 154

A new spring outfit . . .

for your plant, too? Now that's an idea, and maybe we'll promote a society to propagate it. We have a new hat, the family is decked out, so surely the old hrt deserves a brand-new coat of paint? When it comes to accessories, by the way, our four equipment pages list just about everything for the well-turned-out power plant . . .

Plant equipment news, p 158

Sacre de printemps . . .

a little leisure for daydreaming is an unalienable right of spring. How do you know that summer's coming if you don't have time to watch the flowers grow? So now, if never before, you should try shopping by mail, via our listings of manufacturers' booklets. Your name and a stamp on the post card, and we'll do all the rest . . .

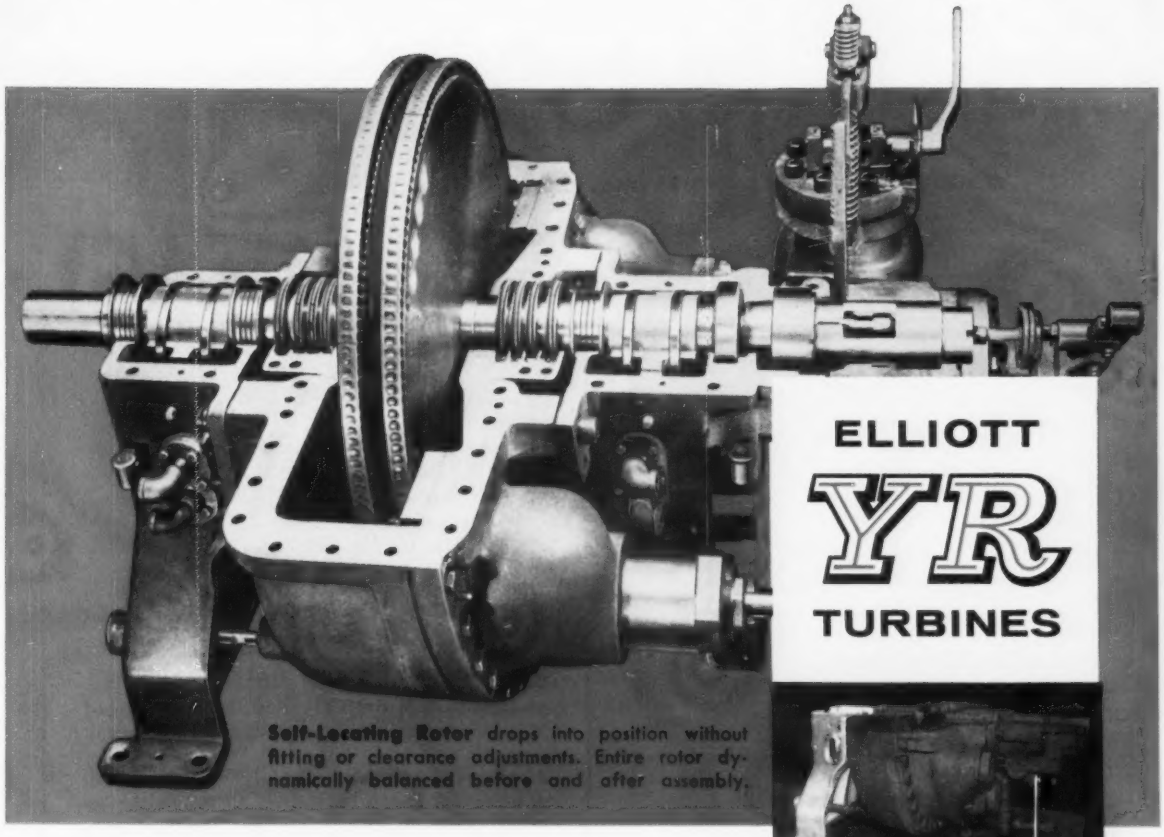
Free literature, p 165

School is almost out . . .

or is it? It's an old adage that education begins where school leaves off—at least, it should. The man with natural curiosity can't help studying and learning, and if he doesn't happen to have a college degree he doesn't waste time worrying about it. What our friend George has to say on the subject is well worth listening to . . .

George Edwards, p 168

For other timely ideas, see following service pages▶



Self-Locating Rotor drops into position without fitting or clearance adjustments. Entire rotor dynamically balanced before and after assembly.

ELLIOTT

YR

TURBINES

5 design features insure ...easy installation ...easy maintenance

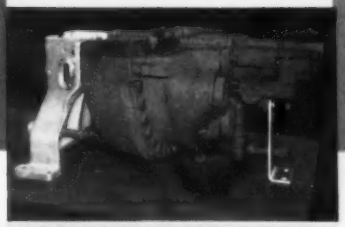
Dependability in long-term, continuous service is the principal reason why Elliott mechanical drive turbines have won such universal acceptance as prime movers for process and water pumps, fans, compressors and other driven machines.

But there's more to it than that. The popularity of Elliott YR single-stage turbines, in sizes from 2 to 600 hp, is also due to simplified design features which provide easy installation and easy access for routine inspection and maintenance. Five of these design features are illustrated here. The Elliott design also permits interchangeability of components from one turbine frame to another.

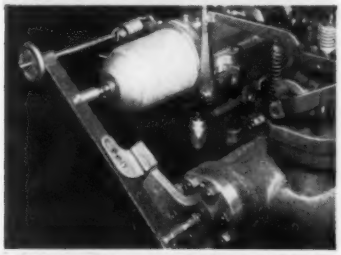
Other types of Elliott mechanical drive turbines are available, in sizes up to 20,000 hp. And when it comes to application engineering or maintenance assistance, your local Elliott field engineer is always available. For complete details write Elliott Company, Steam Turbine Department, Jeannette, Pa. Ask for Bulletin H-22B.

ELLIOTT Company

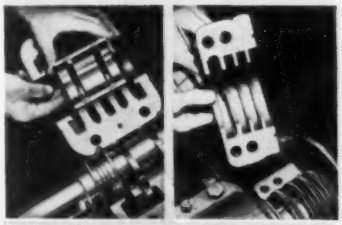
TURBINES FOR DEPENDABLE day-in/day-out SERVICE



True Centerline Support assures accurate shaft alignment over entire range of operating temperatures, extends life of bearings of turbine and driven machines.



Weather-Proofed, Reliable Speed-Governing System maintains effective steam seal for long operating periods. Separate overspeed trip gives positive overspeed protection.



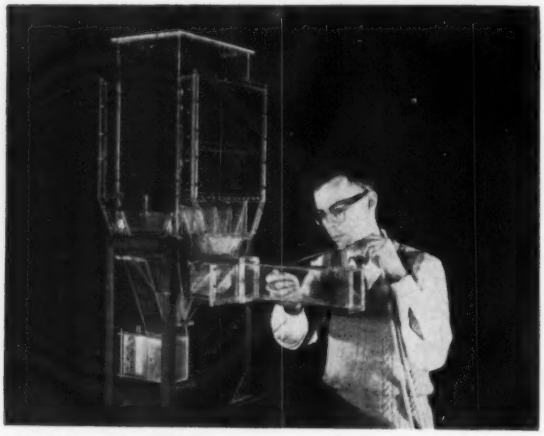
Liner Type Bearings (left) are sealed against elements, permit rapid heat transfer to cooling oil, are easy to inspect or replace.

Accessible Shaft Seal Covers (right) are easy to remove for inspection or ring replacement.

HB-2

Reports from the field

What's happening in power and what it means to you



PRECIPITATOR MODEL is a visual aid for design engineers

Industrial gas-flow studies lead to higher flue efficiency

Study of the mechanics of fluid flow by means of wind-tunnel models has long been standard procedure in the aeronautics field. As a preliminary step in electrostatic-precipitator and flue design and installation, the idea is a recent development—with a pretty big future.

Practice has been to buy (*Continued on page* 214)

Power lines

World's largest gear-type spindle couplings—10 ft long—are part of a new 32-in. rolling mill to roll super alloys, high-speed steels.

Shortage of engineers in this country will continue for at least two decades, says John K Hodnette of Westinghouse Electric Corp. "Shortage of really creative engineers will be with us always."

Russian technical *Journal of Applied Mathematics and Mechanics*, (*PMM*), will be translated on a regular basis by ASME. AIEE has arranged for translations of *Electrical Technology, U.S.S.R.*

Corrosion-resistant wrought iron has been announced by A M Byers Co. Resistance is increased 25% by removing more oxygen from the base metal.

Aluminum bus conductor, the largest ever extruded, is being fabricated by Harvey Aluminum for its primary reduction plant. Bus bars measure 4⅛x20 in. and come in lengths up to 43 ft.

Biggest problem connected with automation is not cost or complex equipment, but reorientation of management thinking to its new range of responsibilities, says James R Bright of Harvard.

For Calendar of Events see page 214

Meet new assistant editor Jim Follansbee

Newcomer J W Follansbee brings a variety of on-the-job experience to his duties with POWER. He's handled inside sales of industrial supplies, worked in a testing lab, and demonstrated electric motors in every large city east of the Mississippi and north of the Mason-Dixon Line.

Born in Pennsylvania, Jim received his BA from the U. of Mississippi. Five years of industrial experience followed. Then he felt the lure of engineering, and trekked to the U. of Florida to complete studies for a BME. While there, he held down the job of editing the student magazine. Hobbies of music, art and golf take up his spare time. On POWER, Jim will concern himself with mechanical-engineering aspects of the power field.

Mobile generators help boost Mexico's industrial growth

Five mobile generating plants, permanently housed in tractor-trailer units, are boosting Mexico's fast-growing industries and helping expand rural electrification.

Each 500-kw generator can fill the power needs of a town of 2500 people. The units incorporate heavy-duty engines built for continuous output. They will be used to bring power to new areas, to help in re-routing present systems, and to meet peaks in power needs across Mexico.

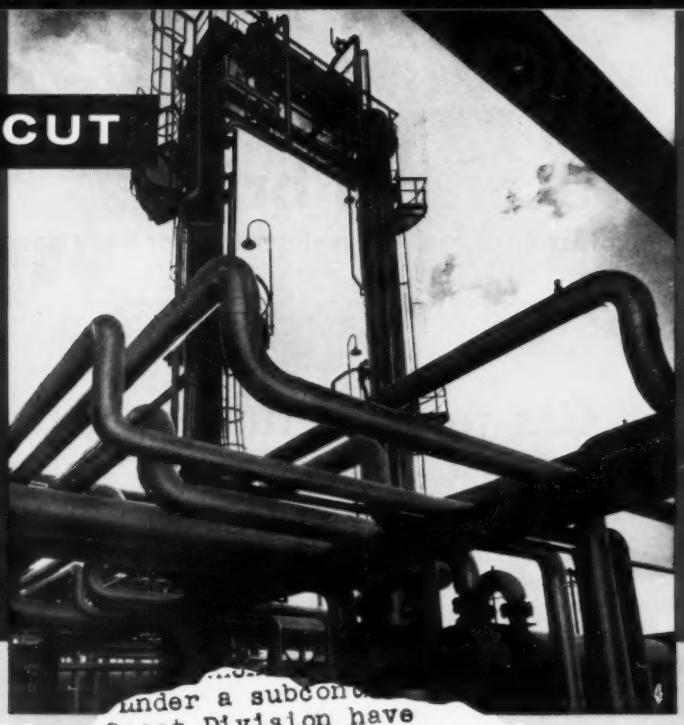
Generators are built into 32x8x 12½-ft trailers. They were bought by the Comisión Federal de Electricidad from the White Engine Div of White Motor Co. The prime mover is a 755-hp diesel engine operating at 900 rpm.

NOT ONE FIELD CUT

in all This

MIDWEST

Shop-Fabricated Piping



...nder a subcon...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

MIDWEST PIPING COMPANY, INC.

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SAN FRANCISCO 11—420 MARKET ST.

8033

Technical briefs

Latest engineering developments for busy power men

11 papers for you on:
GAS TURBINES
HYDRO
POWER GENERATION

Gas-turbine future is bright

Large gas turbines for central station application. *By Z S Stys, Brown Boveri Corp*

The large gas turbine can be considered a reliable machine for power generation. It can be used for either base or peak load.

Natural gas seems to be the ideal gas-turbine fuel, because it leaves no deposit. When operating at conservative gas temperatures, gas-turbine operation and life is comparable with that of the steam turbine.

Light oil can be burned with practically the same reliability as natural gas. Heavy oils, especially bunker C, require periodic shutdowns to wash deposits off the blades. If two fuels must be burned, a special dual-fuel burner can be applied.

A true comparison of gas turbine versus steam turbine can only be made on a plant-to-plant basis. Such factors as smaller area, smaller foundation, lower cubic volume of the complete plant can then be evaluated in favor of the gas turbine. Maintenance for a gas-turbine plant is about one-third that for a standard steam plant. This maintenance cost includes yearly overhaul, cleaning, etc.

The future trend is toward larger and larger units with better efficiency. Largest unit so far is Beznau No. 2: 27,000 kw. The next step will be Edmonton, Canada, with a capacity of 60,000 kw in two 30,000-kw units. Manufacturers have enough accumulated experience to build units larger than 30,000 kw. A 50,000-kw unit could be built, taking the same space as a 30,000-kw unit. Ultimately, even a 100,000-kw unit could be built, taking about the same space and working on the principle of a combined steam and gas-turbine cycle. Steam would be generated at supercritical conditions, and the cycle efficiency might feasibly be over 45%. *AIEE paper, No. 58-164.*

Design and operation of gas turbine generating stations. *By A W Barstow and W D Marsh, General Electric Co*

This paper has been written to provide a guide for those who are unfamiliar with gas-turbine electric-generating stations. The approach is from the standpoint of straight gas-turbine generator sets, for electric-utility application, but most of the material is valid for any purely generator-drive installation.

The material is presented in three parts: (1) general characteristics of gas-turbine electric stations (2) station components and design (3) station operation

The authors conclude that: (1) Electrical design of gas-turbine generating stations is simplified by the small number and size of auxiliaries, and the absence of drives that are extremely critical to voltage and frequency variations during starting and operation. (2) The mechanical design-engineering effort required to produce a complete generating station is relatively small because of the small number of components to require design co-ordination. (3) Attended stations require a minimum of operating manpower. Unattended stations are feasible and economical. *AIEE paper, No. CP-58-163.*

Design considerations for marine gas turbines. *By F R Spurrier, Utica-Bend Corp*

A gas-turbine engine employed as the main propulsion plant in a ship must satisfy design requirements which differ considerably from those for other turbine applications. Naval escort vessels, for example, have duty profile characteristics that demand relatively short periods of operation at maximum power, and long periods at small percentages of maximum power. Normal cruising power may be only 15% of the maximum available, but economy of operation must be assured at this condition. Thus, such engines introduce problems that do not arise in commercial vessels or aircraft machines, where most of the operating life is spent at high percentages of the maximum available power.

The author describes a design philosophy which preserves economy of operation over a large range of power output in a basically simple engine. Requirements and design solutions which evolve and the manner in which these differ from those in aircraft practice are discussed. *ASME paper, No. 57-GTP-7*

Hydro

The evolution of the modern waterwheel generator in Canada. *By G D Floyd, Canadian General Electric Co, Ltd and H R Sills, Hydro-Electric Power Commission of Ontario*

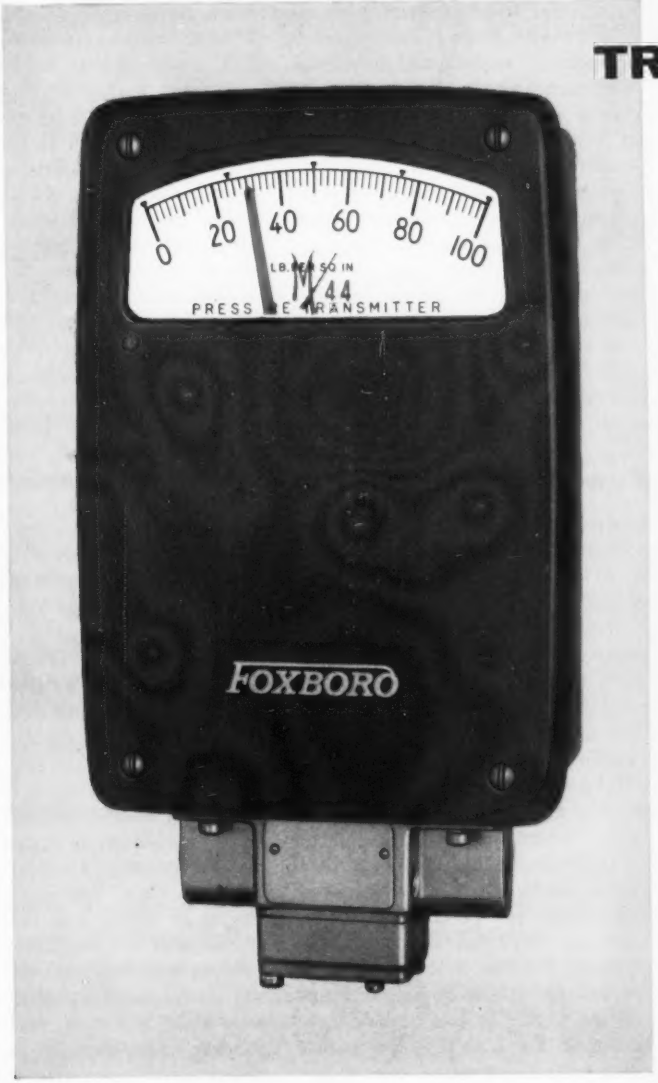
Number and potentiality of power sites, particularly in the industrial provinces of Quebec and Ontario, and the lack of coal in these provinces, has resulted in their extensive development. There has been a continuing demand for generating units of greater capacity and improved reliability.

When considering the almost infinite variations of head, best turbine speed and unit capacity required to meet operating and system conditions, it's apparent that the requirements present a major challenge to the generator designer. This paper records some of the many improvements in design of waterwheel generators made by Canadian manufacturers.

It concludes that the operating and climatic conditions in Canada require special characteristics in the generators. These are concerned with obtaining the utmost output as required by load conditions. As both the base and peak loads are supplied by hy-

read pressure up to 20 ft. away!

on the FOXBORO M/44 INDICATING PRESSURE TRANSMITTER



You can check pressure readings at a glance on the Foxboro Pneumatic Indicating Pressure Transmitter. Its open-face, horizontal, 4-inch indicator scale and eye-catching red pointer are clearly visible as far away as 20 feet.

But high readability is just part of the story. Actually, this instrument was engineered from the ground up. Makeshift arrangements have been eliminated, hung-on gauges are gone. Everything is included in one compact (5¾" x 8⅛"), ready-to-install instrument that weighs only eight pounds.

Because the indicating pointer is direct-connected to element and transmitter, calibration is easy . . . and you can re-zero the transmitter externally. All M/44 components are standard, performance-proved Foxboro parts. This makes it easier to stock and service.

A wide selection of interchangeable Foxboro pressure measuring elements gives the M/44 range limits of 0-30" water to 0-6000 psi. Elevated ranges are available, too.

Write for complete details. **The Foxboro Company, 684 Neponset Ave., Foxboro, Mass.**

FOXBORO REG. U.S. PAT. OFF. **INSTRUMENTATION FOR INDUSTRY**

More **technical briefs**

Begins on page 154

draulic turbines, any unscheduled outage is very serious. Emphasis is given to equipment reliability, to making provisions to keep damage from a possible fault to a minimum, and to providing means for making rapid repairs. *AIEE paper, No. CP 57-689*

Low cost powerhouse vertical waterwheel generators. *By D R Ritcey and C C Sargeant, Canadian Westinghouse Co, Ltd*

It's often possible to design a vertical waterwheel generator that will permit a reduction in the overall cost of the powerhouse. This is done by reducing size of the overhead crane that is normally required. Since the complete rotor of a vertical waterwheel generator is usually the heaviest crane lift, its weight will decide the size of the crane. But it's possible to design the rotor so it will never have to be handled as a complete unit, thus reducing the overhead-crane size.

It's necessary to expose the field and armature coils to permit installation and servicing. This is accomplished by elevating the entire generator stator. The generator described in this paper (installed at Seton Creek Generating Station of the British Columbia Electric Co) is lifted by four 25-ton jacks located under the stator. The jacks are capable of lifting the stator 90 in. vertically.

Generator thrust bearing is made completely accessible from the underside of the generator rotor by using a lowering device that permits bearing inspection, repair or removal in a relatively short time without disturbing any other part of the generator. *AIEE paper, No. 57-688*

The Bersimis-Lac Casse 1¼-million-horsepower development. *By H F Abbott, Quebec Hydro-Electric Commission*

Paper describes unusual features of the development at Bersimis-Lac Casse, which, although it is 400 miles from Montreal, can economically supply the fast-growing load in the Montreal area. The development also will open up the eastern areas adjacent to the St. Lawrence River for desirable industrial development, and make additional power available to the Gaspé and St. Maurice River areas.

Experience and advances obtained to date in long high-voltage transmission lines, large pressure tunnels, underground powerhouses, large rock-filled dams, increased size of hydroelectric generators, were opportune to carrying out the Bersimis development. Only a limited amount of pioneer work had been done, and the advances made were very recent. Facts had to be carefully garnered and comprehensively considered before deciding on design features, particularly when extending practices beyond what had already been applied. Paper explains such features and reasons for adopting them. *AIEE paper, No. 57-695*

Power generation

Controlled starting and loading of modern central power stations. *By F W Kuehn, Pennsylvania Power & Light Co*

This paper outlines experiences in starting major central-station equipment of all vintages under controlled conditions, with emphasis on a new 160-mw 1250-lb 950-F single-shell tandem-compound turbine.

Influence of steam leads between turbine and boiler on turbine end steam temperatures, quenching of valve bowls, relation between horizontal turbine-flange temperature differentials and permissible loading rates are explained in detail. Use of steam from the first turbine stage for heating massive horizontal flange sections in the first to seventh-stage region of the high-pressure turbine as an operating routine, over a 2-yr period, to reduce loading time for starts from cold and after week-end shutdown and to minimize flange distortion is discussed. Boiler-drum circulation difficulties and some innovations in furnace tube-metal temperature measurements are covered. *ASME paper, No. 57-PWR-7.*

Directions for ordering papers on page 220

Design considerations in the development of a cyclone-fired boiler installation for Kodak Park, Rochester, N. Y. *By R L Young, Eastman Kodak Co*

A small number of 1400-psi cyclone-fired boilers are appearing in industry, but much of the industry experience obtained at this pressure has been under conditions similar to those prevailing in utilities.

The cyclone-fired boiler had certain operating characteristics that appeared to suit specific operating conditions at Kodak Park. But application of this type of unit—with 1400-psi operating pressure and 400,000-lb-per-hr boiler size—to a relatively small but complex industrial power system, presented economic and technical considerations that may be somewhat foreign to previous applications.

This paper outlines the conditions under which this power facility was designed and implemented. *ASME paper, No. 57-PWR-1*

Martins Creek Steam Electric Station . . . new ideas to reduce cost of construction and of operation. *By M D Engle, Pennsylvania Power & Light Co*

Pennsylvania Power & Light Company supplies electrical service in a 10,000-sq-mile area in central-eastern Pennsylvania. The Martins Creek Steam Electric Station, placed in service in 1954, was designed for operation at low load factor and the turbines and boilers were designed and instrumented for shutting down each night and over weekends and holidays. They start up under "controlled start" procedures.

Martins Creek is first large coal-burning station of the outdoor type as far north as Pennsylvania. Three winters of operation have demon-

(*Continued on page* 218)

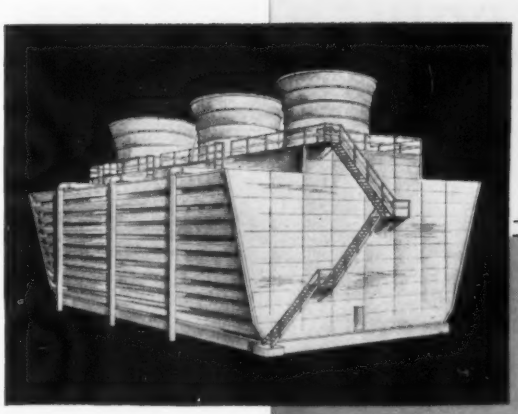
New Class 600

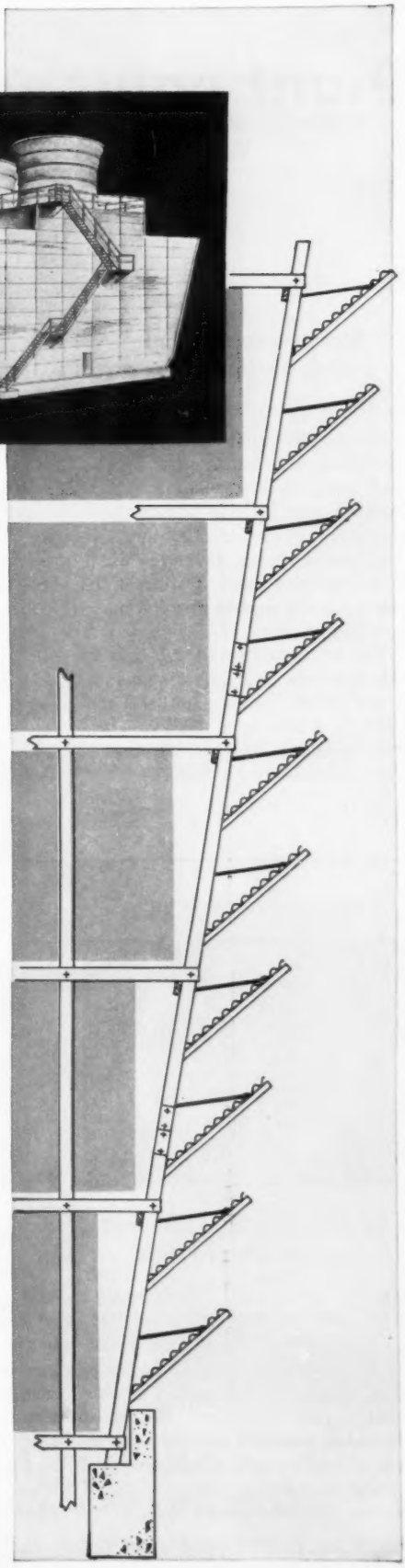
MARLEY

Double-Flow

has the

Profile with a Purpose





Comprised of a combination of "active" angles, the contour of Class 600 cooling towers is completely functional with positive influence on performance and operation. Each angle has its specific purpose and, in conjunction with the others, creates additional advantages.

Louver Angle: The 42-inch louvers are positioned on 3-foot centers at an angle of 40° from horizontal. This arrangement readily admits more air to do more cooling—with inherent lowering of static drop, higher working velocities in the fill become completely practical. It increases the atmospheric performance potential (always greatest in cross-flow towers) and it eliminates splash-out.

Structural Angle: The 10° angle outlined by the louver posts is of equal importance. It makes possible uniform fill width or uniform *air travel* at all levels in the cooling chamber. Result: more performance per cubic foot of structure gained through efficient air utilization.

Fill Angle: With a uniform fill-to-louver distance maintained at every fill story, Class 600 Double-Flows set up an effective barrier against icing. The normal *water travel* creates a continuous curtain of water between fill and louvers without splash-out. There are no non-functional voids so the heat of the water prevents formation of sheet ice and blocking of air entrance.

MARLEY

The Marley Company

Kansas City, Missouri

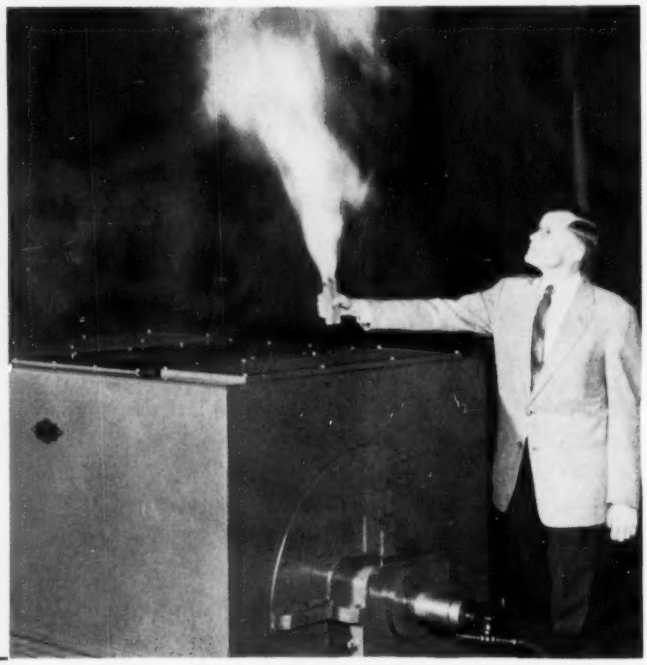
Plant equipment news

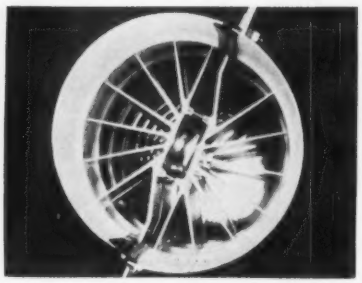
Your information center for new products and materials

Straight-up ventilation stops air interchange

401 • Induction-motor line features straight-up ventilation, silent operation. For power-plant boiler-feed pump service, motors can be installed side by side without interchanging ventilating air, manufacturer states, because they draw air in at bottom and expel it straight up. Units are also said to give low-noise-level operation.

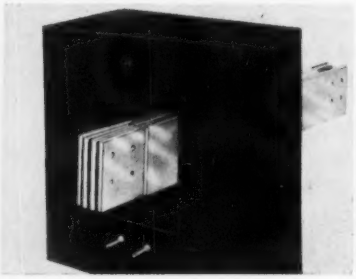
Picture illustrates the straight-up principle—smoke bomb marks outlet-air stream. Motor shown is rated 1250 hp at 3600 rpm, 2300 v.—*Electric Machinery Mfg Co, 800 Central Ave, Minneapolis 13, Minn.*





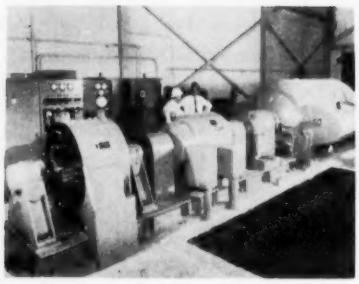
Cooling-tube arrangement ups rectifier output

402 • Up to 12 fin assemblies can be stacked in series in this germanium rectifier cooling tube, maker claims. Result is said to be a 20 to 25% higher cell rating for plating rectifier power supplies. Design of air-cooled assembly permits orientation of rectifier cell in tube assembly without sacrificing rating.—*General Electric Co, Schenectady 5, N. Y.*



Metering system handles high direct currents

403 • Transducer unit utilizes an ac transformer through which dc bus bar or cable is passed. Slip-over feature avoids direct connections. Current ranges vary from 500 to 500,000 amp with a stated accuracy of .5 to 1%. Unit comes with isolation and ac transformers and a selenium rectifier.—*Rapid Electric Co, 2881 Middletown Rd, New York 61, N. Y.*



Synchronous condenser stabilizes voltages

404 • This 30,000-kva unit is designed to control arc-furnace fluctuations. It is rated at 13,800 v, 3600 rpm, 3 phase, 60 cycle. High velocity hydrogen gas in direct contact with conductor copper cools stator and rotor coils, permitting size reduction. Transient reactance is 20.6%, maker claims.—*Allis-Chalmers Mfg Co, Milwaukee 1, Wis.*

For more data on these items, use post cards on page 165. Identify your request with item number.

CRANE Pressure-Seal Bonnet Valves

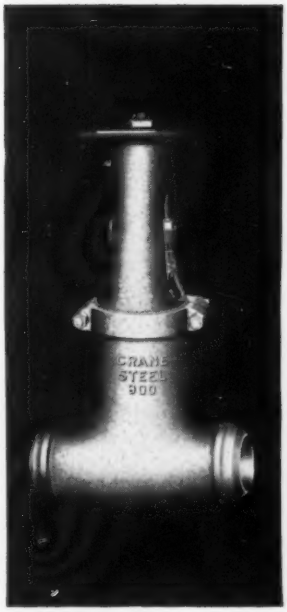
In gate, globe, angle and stop-check patterns—flanged, butt- and socket-welding ends—rated in accordance with A.S.A. in 600-, 900-, 1500- and 2500-pound classes. Sizes: gates—1 to 24 inches; globes and angles —1 to 16 inches; checks—2½ to 12 inches; stop-checks—6 to 12 inches

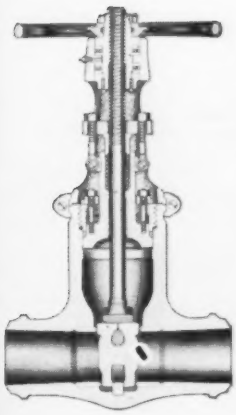
Crane design is at its very best in this streamlined line of pressure-seal bonnet valves—made expressly for high-pressure/high-temperature service in central stations and industrial power plants.

Bonnet joints in these valves are sealed by a unique method which uses *internal fluid pressure* to effect a leakproof seal. This method virtually eliminates bonnet-joint maintenance—and maintenance costs.

Other features include: weight-saving body design —saving up to 60% over conventional design—swivel action yoke and clamp which permits choice of position for motor or gear mechanism . . . one-piece sealing ring . . . Stellited seating surfaces.

Write to address below for descriptive Circular 1936.





CRANE *high-pressure/temperature valves assure leakproof service–less maintenance*

CRANE Lip-Seal Bonnet Valves

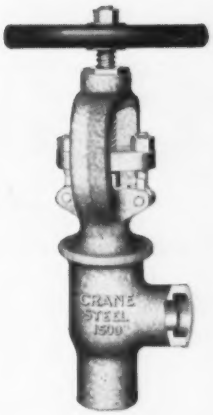
In globe, angle and lift-check patterns; sizes—½ to 2 inches; screwed and socket-welding ends; rated in accordance with A.S.A. in 1500- and 2500-pound pressure classes

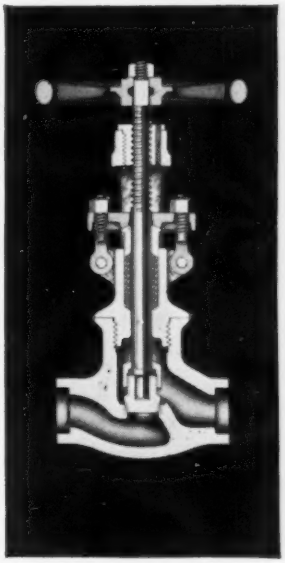
These popular Crane valves are widely used on steam, boiler feed, drips, drains, by-pass, blowdown and similar piping services.

They assure you absolute tightness, no bonnet-joint maintenance, minimum valve weight and bulk without sacrificing strength—and easy, fast dismantling and reassembly.

Features include: lip-seal design which permits re-welding without damage to the valve . . . improved disc-stem connection that minimizes vibration . . . two-piece, non-binding ball-type gland construction . . . and Stellite seating surfaces.

For details, write to Crane Co., for Circular 2099.





For prompt personal service, see your Crane Representative.

CRANE VALVES & FITTINGS

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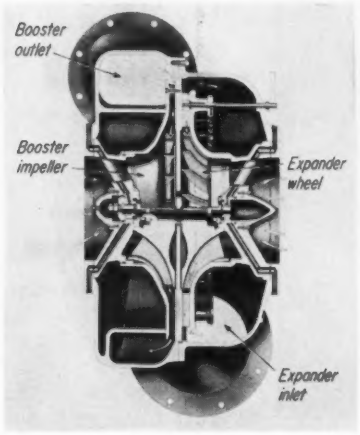
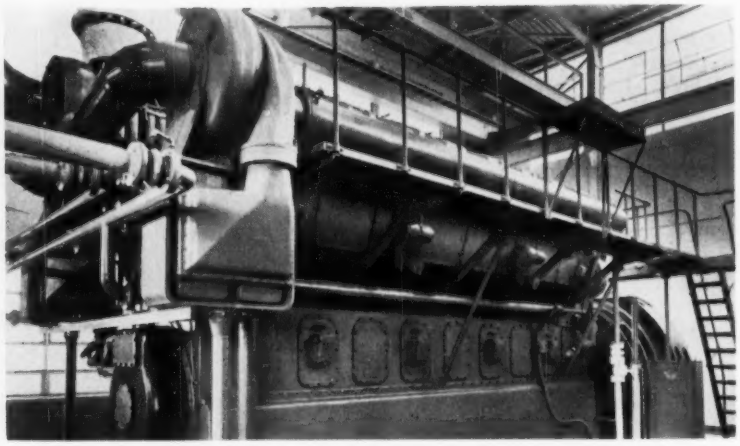


BOOSTER increases heat, pressure of the air



TURBOCOOLING SYSTEM is installed in supercharged gas engine rated at 4380 hp

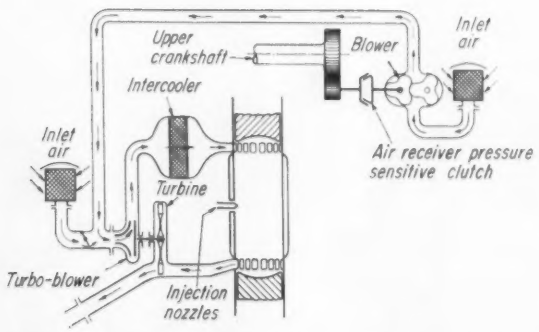
Turbocooler ups hp 23%, cuts fuel consumption by 5%

405 • Field experience indicates that combustion-air supercooling can increase hp output of gas and gas-diesel engines up to 23%, reduce fuel consumption 5%, maker states.

Turbocooling can be used with new and existing engine equipment. The first units went into service in January 1955, giving stated fuel economies as good as 6010 Btu per bhp-hr.

Turbocooler is a turbine-driven centrifugal compressor equipped with an aftercooler. Filtered air enters h-p turbocharger, is compressed by exhaust-gas-driven centrifugal blower. Second compression (booster) stage increases heat and pressure.

Air is then cooled and enters turboexpander. Pressure is greater than air-intake requirements of engine; resulting pressure drop is used to spin expander impeller. As air expands through the impeller, its temperature is reduced 15 to 40 F. This gives cool combustion air for engine, raising efficiency. —*Cooper-Bessemer Corp, Mt Vernon, Ohio.*



AUXILIARY BLOWER discharges into suction of the turboblower

Supercharged diesel boasts 50% power gain

406 • Turbo-supercharged opposed-piston 2-cycle diesel engine is said to be smallest and lightest commercial unit in its horsepower range. Unit saves 5 to 10% in fuel consumption; capacity is increased 50%, maker states.

Both 6- and 12-cylinder models are available with turbocharging. Weight of 6-cylinder basic engine is 24,900 lb and the 12-cylinder unit weighs 46,200 lb—gains of only 2000 and 4000 lb over nonsupercharged models.

Top rating for the 12-cylinder diesel is 3600 hp at 900 rpm. Most stationary power-plant installations will probably operate at 720 or 750 rpm, standby units at 900 rpm. High-altitude performance is good because supercharged engines are less sensitive to atmospheric pressure than conventional units.

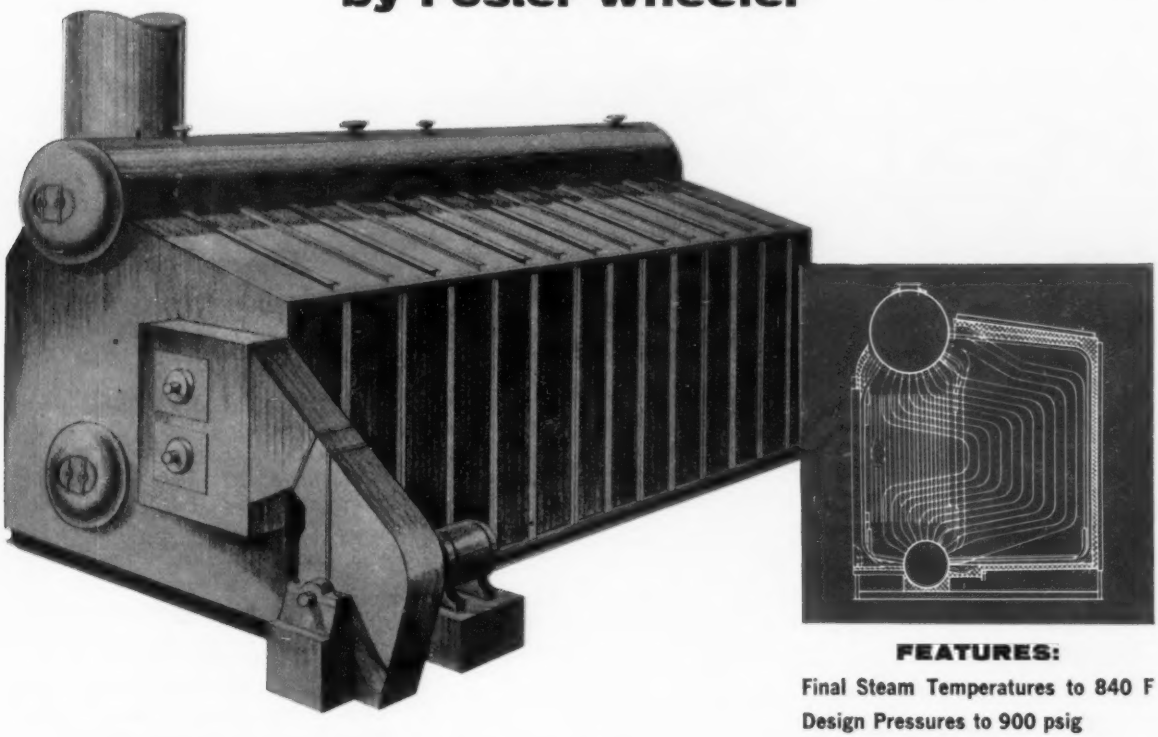
Exhaust gas flows from the exhaust ports by way of divided manifolds through gas-turbine section of turbocharger. Turbocharger blower compresses air to required air-receiver pressure. Scavenging air is cooled on its way from blower to receiver, providing a dense charge for each combustion cycle.

Exhaust energy recovered in turbine usually gives enough scavenging air, but below one-third load an engine-driven blower is needed to increase supply. Auxiliary blower discharges into suction of the turbocharger blower; a check valve prevents loss of air to atmosphere. —*Fairbanks, Morse & Co, Chicago 5, Ill.*

For more data on these items, use post cards on page 165. Identify your request with item number

HIGH CAPACITY PACKAGED STEAM GENERATORS

by Foster Wheeler



Series AG-200 extends economy and dependability of FW Packaged Design to over 60,000 lb/hr

To meet the needs of industrial plants for high-capacity Packaged Steam Generators, Foster Wheeler offers units for capacities of 50,000 to 63,000 lb/hr and higher, depending on operating conditions.

A modification of the proven AG-100 design which has provided industry with reliable, economical steam in the range of 10,000 to 50,000 lb/hr, these compact, space-saving units permit more steam capacity in less space than has heretofore been possible. For complete details, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FEATURES:

- Final Steam Temperatures to 840 F
- Design Pressures to 900 psig
- Standard Heat Recovery Arrangements Available
- 42-inch Steam Drum
- Two Burners
- Automatic Controls
- Suitable For Indoor or Outdoor Installation
- Tangent Bare Tube Furnace Side Walls and Roof
- Staggered Boiler Bank Tube Arrangement
- Fully Drainable and Removable Superheater.

THE FOLLOWING AG-200 UNITS ARE NOW IN PRODUCTION:

Capacity lb/hr	Operating Pressure psig	Final Steam Temperature Deg. F	Feedwater Temperature Deg. F	Fuel	Efficiency	Steam Quality
52,500	400	750	200	No. 6 Oil	85.5	3 ppm Solids Carryover
60,000	285	Sat.	220	Nat. Gas	78.3	3 ppm Solids Carryover
63,700	150	Sat.	225	No. 6 Oil	83.7	0.5% Moisture Carryover
68,000	620	Sat.	350	No. 6 Oil	80.9	1 ppm Solids Carryover

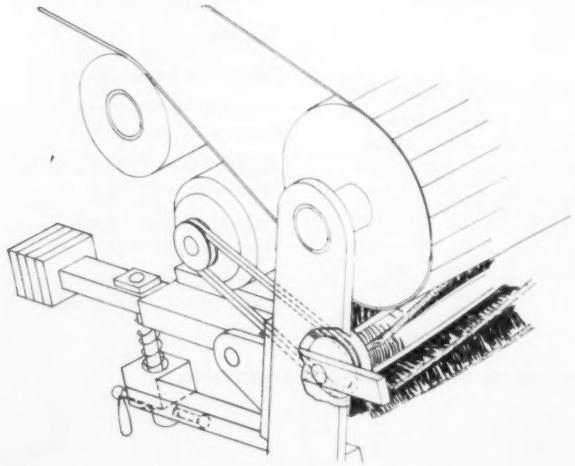
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

NDT radiography unit gives sharp detail

407 • Portable, lightweight industrial unit is said to provide sharp detail and good penetrating power. Unit can handle nondestructive-testing duties involving steel welds, opaque materials.

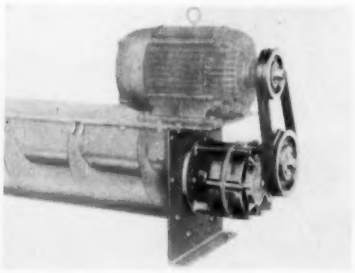
Unit weighs 45 lb, comes in a 16x12x6¾-in. enameled-steel case. X-ray generator and tube are enclosed in a shockproof and radiation-proof 55-lb steel tank. At full load—100 kvp at 4 ma—unit can be operated for 50 min. *Instruments Div, Philips Electronics Inc, 750 S Fulton Ave, Mt Vernon, N. Y.*



Helical brush handles coal "carryover"

408 • One solution to the problem of material "carryover" on conveyor-belt systems is a unit-type brush made of heavy-duty helical brushes set in strips. Rotary setup gives effective sweeping action; interrupted face is said to allow individual strip brushes to flex and clean themselves. Brushes will last as long as a year.

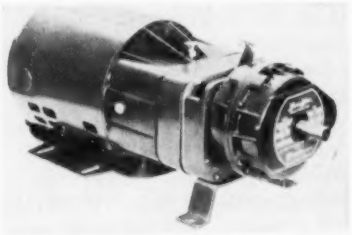
In illustrated application, the brushing unit is driven by belts from the header roll. A counterweight regulated by a dampening spring maintains brush contact with belt, compensates for wear.—*Osborn Mfg Co, Hamilton & Marquette St, Cleveland 14, Ohio.*



Screw-conveyor drive is now packaged

409 • Screw-conveyor drive is easily mounted and adjusted on standard conveyor troughs. It consists of a speed reducer with packing gland and driving shaft that mounts on the trough end. Maximum efficiency is achieved through use of heat-treated AGMA-rated helical steel gears and pinions, maker states.

Heavy-duty tapered bearings are used for thrust and radial capacity. Sliding motor base is eliminated and slotted holes in reducer flange permit rotation for quick adjustment of the V-belt drive center distance.—*Dodge Mfg Corp, Mishawaka, Ind.*



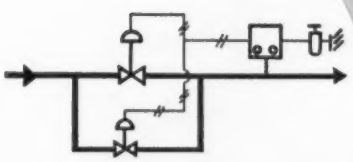
Reduction gearheads added to speed reducer

410 • Addition of reduction gearheads of various ratios to the motorized variable-speed reducer provides torque ratings of 20 through 120 in.-lb. Combinations give speed ranges from 0-80 to 0-200 rpm. Standard motor is a 48-frame 115-v 60-cycle single-phase open dripproof type.—*Revco Inc, 1900 Lyndale Ave S, Minneapolis 5, Minn.*

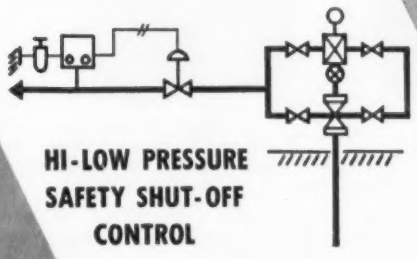
For more details on these items, use post cards p 165. Identify your request with item number.

For Optimum Pressure Control, Specify BS&B 72-14 Pressure Controllers And Transmitters!

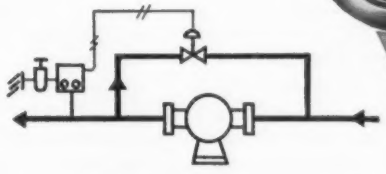
Proportional ★ On-Off ★ Differential Gap
Indicating Or Non-Indicating



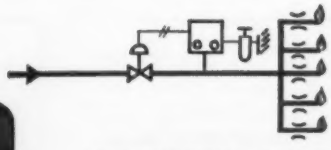
PRESSURE REDUCING CONTROL



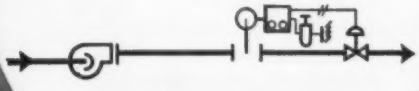
HI-LOW PRESSURE SAFETY SHUT-OFF CONTROL



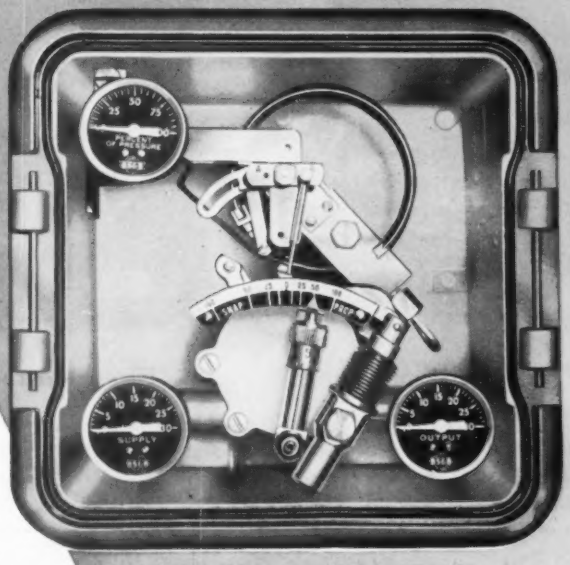
BACK PRESSURE CONTROL



LOW PRESSURE CONTROL



DIFFERENTIAL PRESSURE ...FLOW CONTROL



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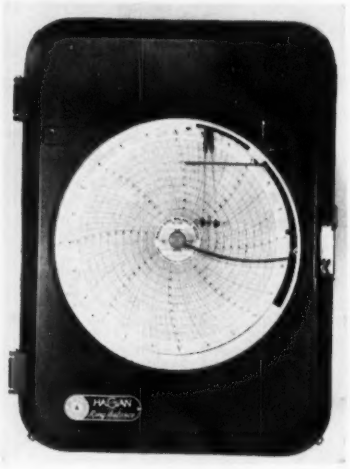
Controls Division, Dept. 4-Q4
7500 East 12th Street
Kansas City 26, Missouri

More **equipment news**

Begins on page 158

NDT thickness tester

411 • Instrument is designed for precise nondestructive measurement of the thickness of coatings and platings. It can be used to test metallic film or foil from .00005 to .007 in. thick, and can detect cracks in smooth and rough coatings, flat stock and tubing. Instrument operates on swept-frequency eddy-current principle.—*Gulton Industries Inc, 212 Durham Ave, Metuchen, N. J.*



Electronic recorder

412 • Unit is said to receive and record output from up to four remote ring-balance meter-operated slide wires. It can record fluid density, liquid level in open or closed vessels, boiler-drum water levels and temperature- and pressure-compensated fluid-flow. Comes as ac bridge, dc potentiometer or voltmeter.—*Hagan Chemicals & Controls Inc, 323 Fourth Ave, Pittsburgh, Pa.*

Potentiometer pyrometer

413 • Portable unit has four interchangeable scales added, is used to check and calibrate temperature instruments actuated by any one of ten types of thermocouples. It can check any thermocouple-actuated temperature recorder, indicator or controller in a range of 32 to 3215 F. The unit can also measure dc potentials from 0 to 155 mv.—*Technique Associates Inc, Box 91, Indianapolis 6, Ind.*

For more data on these items, use post cards on page 165. Identify your request with item number

"Personal" calculator weighs only six pounds

414 • This 10-key calculator can add, subtract, multiply and divide. The unit is manually operated, but has no "handle." An actuating bar similar to the bar on electric machines is depressed with the palm of the hand, without taking fingers from the keyboard. Calculator can be used by a beginner after ten minutes of instruction.

Unit is said to work as fast as larger electric models. It has a capacity of ten digits entered, eleven total. Standard 10-key operation is used; subtotals are shown at every step, and subtraction is direct.

Overall size of *BDC Contex* is 10x7x3¾ in., so it can be carried in a briefcase for fieldwork, business trips, manufacturer suggests. The 6-lb unit costs $125.00—*Bohn Duplicator Corp, 444 Fourth Ave, New York 16, N. Y.*

Don't miss this item . . .

Panel meter . . . . . p 170

. . . or other product news appearing on following pages

Spray lubricator . . . . . p 170
Oil bath aftercleaner . . . . p 172
Engine analyzer . . . . . p 172
Chemical injector pump . p 174
Rectifier junctions . . . . . p 176
Main-line meter . . . . . p 176
Molded transformers . . . . p 178
Conveyor oiler . . . . . p 178
Radiation monitor . . . . . p 180

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follow these easy steps

Preceding pages tell you what's new in plant equipment. Each item is numbered. For more details on any item, write its number here →

New free bulletins are listed and numbered, beginning on back of this page. To order those you want, write POWER item number here — *do not use manufacturer's bulletin number.* →

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Power
Reader Service Department
330 West 42nd Street
New York 36, N. Y.

AIR CONDITIONING, HEATING REFRIGERATION, VENTILATION

1 **High-temperature** heat fans from 600 to 30,000 cfm, to handle up to 1650 F, are subject of 20-p bulletin *HF-100*. Gives performance and selection data, specs. General Blower Co, 8611 Ferris Ave, Dept H, Morton Grove, Ill.

2 **Dust-collection** equipment is described in 6-p bulletin *A-9157*. Illustrates complete line of wet- and dry-type collectors and auxiliary equipment. The Ducon Co, Inc, 147 E 2nd St, Mineola, L. I., N. Y.

3 **Hermetic centrifugal refrigerating machines** for capacities from 90 to 1100 tons are discussed in 28-p catalog *19C-104*. Includes rating tables, sizes, kw input, dimensions and diagrams. Carrier Corp, Syracuse 1, N. Y.

4 **Air conditioning,** refrigeration equipment is subject of 34-p bulletin *80-E*. Contains refrigeration tables, physical descriptions, illustrated application info. Frick Co, Waynesboro, Pa.

5 **Ash handling,** dust control, air-classifying equipment is discussed in 24-p booklet. Photos, diagrams illustrate catalog. Fluor Products Co, Whittier, Calif.

ELECTRICAL EQUIPMENT

6 **Connection techniques,** connectors, installation tooling is covered in 100-p manual. Contains basic principles of splicing, tapping, deadening. Illustrated with photos, drawings, charts. Burndy Corp, Norwalk, Conn.

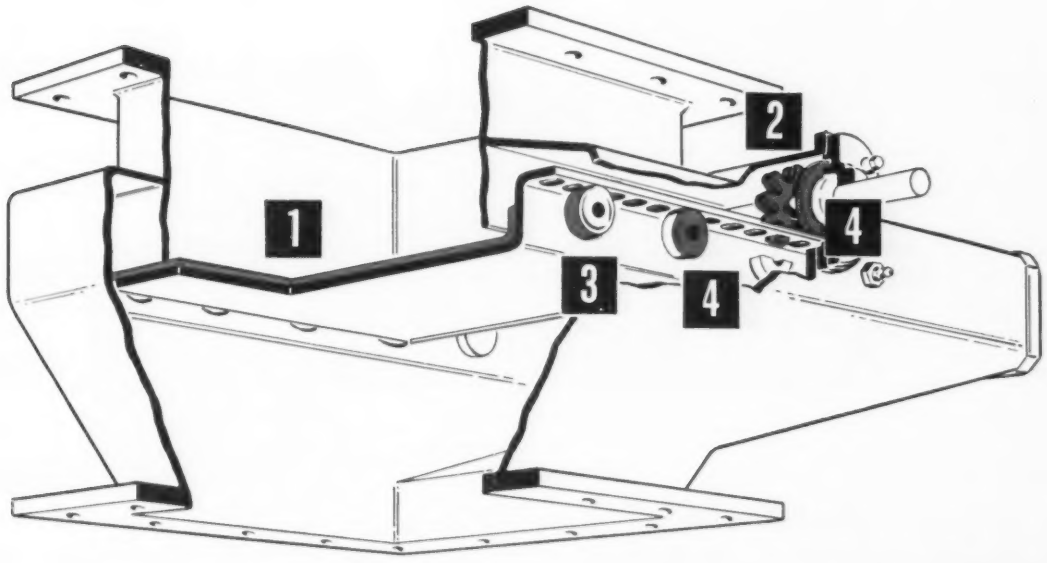
7 **Large induction motors** are described in 16-p bulletin *1950*. Gives info on motors rated 150 to 1250 hp, includes cutaway drawings. The Louis Allis Co, 427 E Stewart St, Milwaukee 1, Wis.

8 **Electrical contacts** are discussed, illustrated in 16-p general catalog *C-520*. Includes silver, palladium and nickel contacts. Outline helps selection. Gibson Electric Co, Box 630, Delmont, Pa.

9 **Industrial batteries** for switchgear, alarm-system, emergency-lighting applications are subject of bulletin *GB-1783*. Contains complete specs, installation data for 40 to 960 amp-hr units. Gould-National Batteries, Inc, Trenton 7, N. J.

10 **Low-voltage distribution** equipment, components are subject of 144-p general catalog. Has info on safety switches, disconnect and open-knife switches, circuit breakers, panelboards, busway. Distribution Unit, General Electric Co, Plainville, Conn.

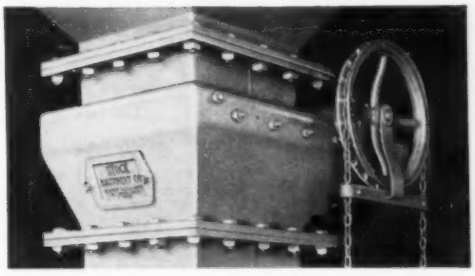
(*Continued on page 222*)



The inside story

ON THE S·E·CO COAL VALVE . . .

STAINLESS STEEL



Wherever you find coal you find corrosion—or the possibility of corrosion. And wherever you find corrosion you find valves that stick, are hard to operate and that will soon need replacement.

Stainless steel resists corrosion — makes valves that are easy to operate and that have a much longer life. That's why Stock Equipment Company has made stainless steel a *standard material* for certain vital parts of the S-E-Co. Coal Valve.

Take the deep U-shaped gate, for instance. The stainless steel liner (1) on top combats corrosion. This not only means longer life, but by preventing pitting it reduces friction when closing against a head of coal.

Multi-faced pinions (2) located above the self cleaning racks are also of stainless steel. By withstanding corrosion the thin pinion sections maintain their strength and are thin enough to make racks and pinions truly self-cleaning.

In addition, stainless steel is used for the shells of the gate-supporting rollers (3) and for the grease seal retainer rings on roller and shaft bearings. (4).

For dependable, efficient valve operation, get S-E-Co. Coal Valves which feature stainless steel as a standard material. If you have a particularly severe problem of corrosion, Stock Equipment Company can help insure normal operation and long life by making the valve body itself entirely of stainless steel.

STOCK Equipment Company

745-P HANNA BLDG. • CLEVELAND 15, OHIO

George Edwards

suggests: Scrap your mental 'limit controls'

Every so often my mail includes letters from guys who have an old, familiar bone to pick: What're the odds on sound practical experience when it comes up against a college degree?

I've always steered clear of this sort of argument because I think it's nothing short of pointless. But I'm going to put my two-cents worth in just this once.

Chief beef is that the college graduate always beats out the job-experienced guy—even one who has a lot on the ball—when it comes to being hired or getting a promotion.

It's true that some personnel people have a tendency to put too much emphasis on formal education—"even if a guy has a degree in dishwashing from Siwash U, he's in"—one letter puts it. But I think this is the exception rather than the rule. Smart plant management is quick to recognize ability and use it to advantage at every opportunity. It's a question of what's best for overall operation and if the *right* man doesn't happen to have a college education, it won't keep him from getting the job.

It's too bad that so many men nurse an inferiority complex all their lives simply because they didn't go to college. They let this frustration loom so large in their minds that it stifles the natural ability they possess and could have developed.

There's a big difference between education and intelligence, and while a college education certainly helps to *develop* intelligence, it doesn't *guarantee* it. Not by a long shot. No doubt about it, a college-trained man has a lot of advantages and nobody will quarrel with the statement that formal education is becoming increasingly more important. But a man *can* be educated without college and he *can* be successful without a diploma — if he really wants to.

Thomas Edison never finished high school. Neither did Henry Ford. And how about Henry Kaiser, David Sarnoff or Admiral Lewis Strauss? They aren't college graduates. I'm not saying that a college education isn't desirable, but these men have proved that it isn't the only passport to success.

It's almost impossible for a guy to go through life without picking up some learning. How much depends on how eager, and naturally curious, he is. Nowadays, the trend is to specialization. And if a man specializes in one field, he must neglect others. There's no basis for frustration if you don't happen to know anything about certain subjects. Many college men, and college professors, too, are in the same boat.

Most noncollege guys have generally worked in one or two fields more than any others. Chances are you know a lot about your specialty. So why not learn more? Study everything you can get your hands on. The more you study, the more you'll realize how much knowledge is available to you. Remember this: All of man's present-day knowledge is between the covers of books and college classrooms don't have a corner on those. No place in this great country of ours is far from a library, or some other book source. If you can read, nothing can stop you from scrapping your mental "limit controls"—and really going places.

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Style 450 Sheet; Style 550 Cut Gaskets

widely used for their RESISTANCE TO OIL!

This compressed asbestos sheet packing of The Anchor Packing Company, homogenous in construction, contains an oil-resisting compound. It is approved by the Underwriters' Laboratories.

Ankoprene sheet is used in services involving petroleum oils and distillates, as well as gasoline and all petroleum derived solvents. Ankoprene gaskets are ideal on refrigerating compressors handling Freon or other refrigerants.

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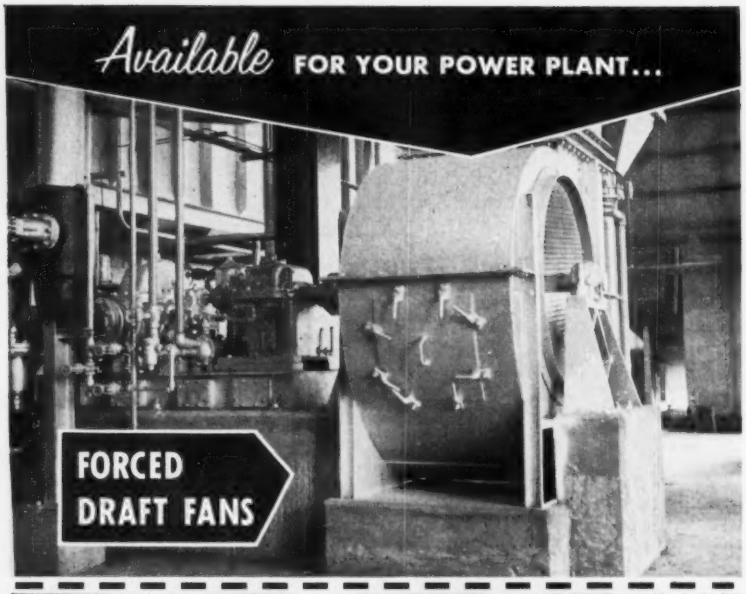

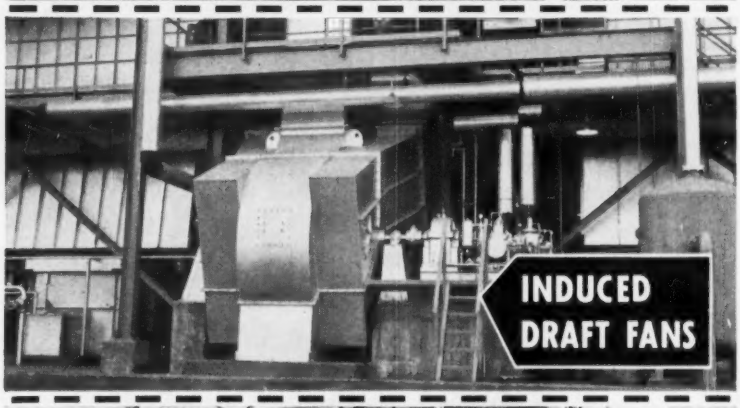

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Equipment can be engineered and designed to meet variable operating conditions. Prompt quotations upon request.

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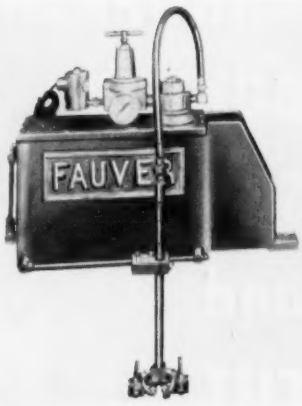
Equipment news

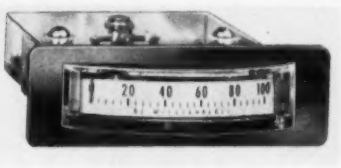
Begins on page 158



Automatic spray lubricator

415 • Unit is designed for continuously and automatically lubricating chains that are moving rapidly or are close-coupled. Model, designated *115X-S*, applies thin coat of lubricant to chain links. Air passes through solenoid valve into lubricator reservoir; lubricant is conducted from reservoir through tubing to outlet nozzles which spray lubricant continuously on chain.—*J N Fauver Co Inc, 51 W Hancock St, Detroit 1, Mich.*

For more details on these items, use post cards p 165. Identify your request with item number.



Panel meters

416 • Panel instruments were designed to save space. The units use core-magnet movement, and are said to be accurate to ±2% of full scale deflection in dc ranges.

Units weigh five oz. They come in dustproof lucite cases, complete with bezel and escutcheon plate.—*Simpson Electric Co, 5200 W Kinzie St, Chicago 44, Ill.*

Wear-resistant alloy

417 • Highly alloyed foundry product is devised to produce castable shapes, stand up under extreme abrasion. A composition of hard, complex carbides embedded in a matrix of unstable austenite, mate-

STRONGER and SAFER for every high pressure pipeline duty...

...because they are drop forged by

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Send for Catalog F-9

Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

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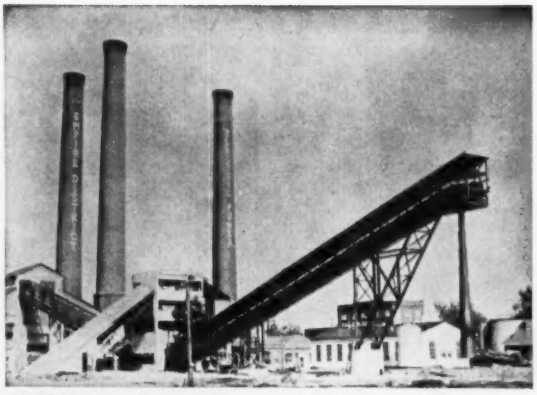
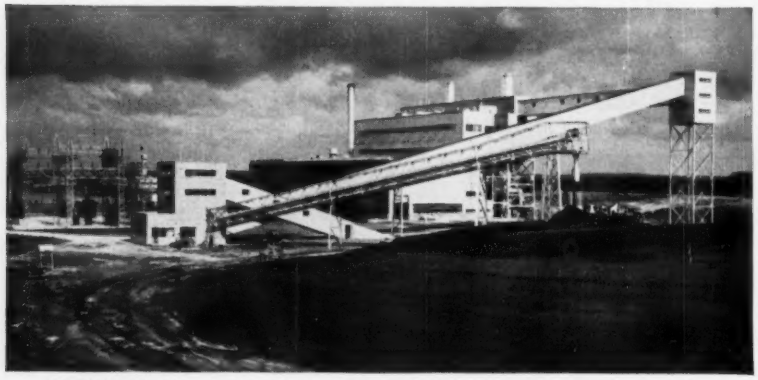


McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.



McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

—With Cost-Cutting

COAL-HANDLING SYSTEMS

Engineered for Your Plant

Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?

Why pay more? Why risk breakdowns, when you can *save* extra "profits" and be sure of year-round efficiency.

McNALLY PITTSBURG Systems automatically handle more coal per dollar—minimum maintenance costs.

The men who know coal from the ground up will be glad to study your coal-handling problems with you. Mail coupon.

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"The Men Who Know Coal From The Ground-Up"

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Gentlemen: Send more information on your Coal-Handling Systems.

Name_____ Title_____

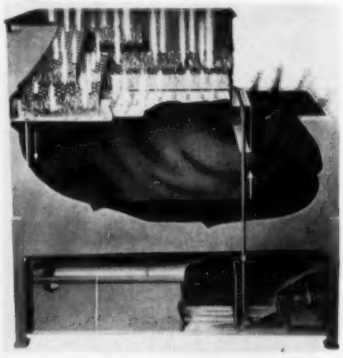
Company_____

City and State_____

Equipment news

Begins on page 158

rial is said to be especially resistant to wear by powdered glass.—*Calumet Steel Castings Corp, 1636 Summer St, Hammond, Ind.*

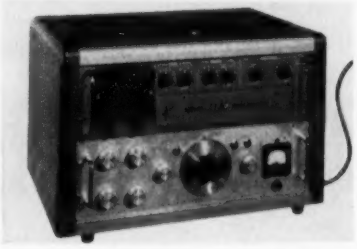


Oil bath aftercleaner

418 • Automatic self-cleaning dust collector separates dust from air as it passes through a viscous crimped-wire fluid bed pad. Dust-laden air is mixed with oil by means of a perforated plate over which oil flows from a central distributing point.

High collection efficiency of unit is said to permit recirculation of cleaned air back into workroom.—*American Air Filter Co Inc, 215 Central Ave, Louisville 8, Ky.*

For more details on these items, use post cards p 165. Identify your request with item number.



Engine indicator-analyzer

419 • Unit measures directly all internal-combustion engine pressures, vibrations and ignition voltages, according to maker. Combined electronic pressure indicator and engine analyzer is said to utilize electrostatic principle to make precision dynamic measurements. Applications include trouble-shooting, diagnosis, monitoring and adjustment.

The system is built around a Swiss-made quartz-crystal pressure gage, which provides visual display of vital

"Failure here can cost $50,000"

Installing Chase Antimonial Admiralty Tube in condenser of Unit #4 at the Eastlake Plant of The Cleveland Electric Illuminating Company. Unit uses 16,150 Chase tubes totalling 484,500 ft. in length, removes 988 Btu of heat/lb. of steam when condensing 1,046,830 lbs. of steam/hr.

Construction Superintendent reports reasons why construction firm plays it safe with Chase® Tube

Merle C. Anderson, Construction Superintendent for Worthington Corporation when they tubed Unit #4 at the Eastlake Plant of The Cleveland Electric Illuminating Company says:

"Condenser Tube failure can cost up to $50,000, so we have to start out with a top product. Chase Antimonial Admiralty Condenser Tube will give us good, efficient service for over 20 years."

Power plant operators everywhere know that Chase® Antimonial Admiralty Condenser Tube gives longer, more trouble-free service. Reason is its far superior resistance to breakdown caused by corrosion, high temperatures and water-borne impurities. Plus values of Chase Tube include good strength and hardness, high thermal conductivity and resistance to fatigue, wear and abrasion.

It will pay you in better service, less down-time and longer tube life when you specify Chase Antimonial Admiralty Condenser Tube—either for retubing or as original equipment. Talk it over with your nearest Chase Representative—locally or at Waterbury 20, Connecticut.

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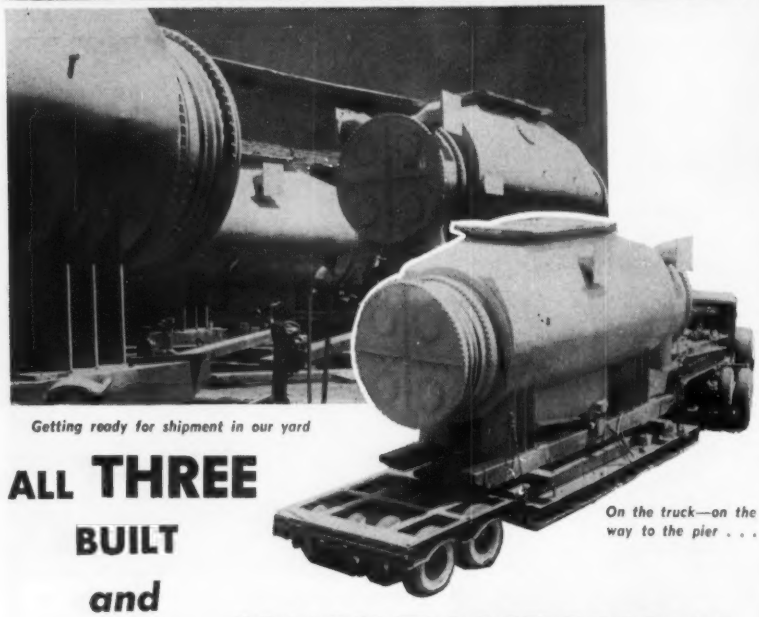
Another overseas shipment of CONSECO CONDENSERS



Getting ready for shipment in our yard

On the truck—on the way to the pier . . .

ALL THREE BUILT and SHIPPED SIMULTANEOUSLY

The production facilities of CONSECO are once again illustrated by the simultaneous building in our own plant in Hoboken and shipping from there three Condensers destined for use in a steam power plant in the Far East.

Presently under construction in our Shops are a 45,000 sq. ft. Condenser for the City of New York, and one 50,000 sq. ft. unit for Dairyland Power Cooperative.

Big or small, Conseco Equipment is the first choice of Engineers who have well-placed confidence in our more than 30 years experienced engineering, sound design, dependable manufacturing and better performance.

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For more data consult Chemical Engineering Catalog pages 559-562

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All Evaporating, Feedwater Heating, Condensing, Air Removal and Condensate Cooling Equipment required in any Thermal Power Generating Plant.

Condensers • Evaporators • Deaerators • Converters
Feedwater Heaters • Steam Jet Air Ejectors

Equipment news

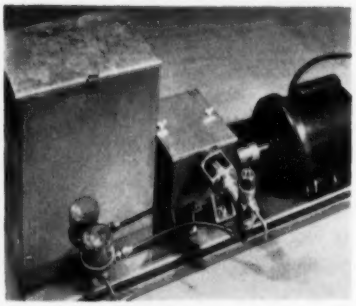
Begins on page 158

engine functions on a standard oscilloscope screen. — *Kistler Instrument Corp, 15 Webster St, North Tonawanda, N. Y.*

Residual-chlorine analyzer

420 • Unit is said to provide continuous automatic measurement of free, combined or total residual chlorine in water or sewage. Essentially a double light-beam filter photometer, it's accurate to within ± 1% of maximum range, maker states. Use of split beam is said to eliminate effect of color or turbidity of sample.—*Fischer & Porter, 465 Jacksonville Rd, Hatboro, Pa.*

For more details on these items, use post cards p 165. Identify your request with item number.



Chemical injector pump

421 • Electric motor-driven pump is said to accurately inject measured amounts of liquid chemicals into flow lines and pressure vessels against pressures up to 1200 lb. Unit is oper-

POWELL

world's largest family of valves

Fig. 1365A - Small Steel Pressure Seal "Y" Check Valve for 1500 pounds W.S.P. Socket weld ends. Sizes ½" to 2". Also available for 2500 pounds in sizes ½" to 3".

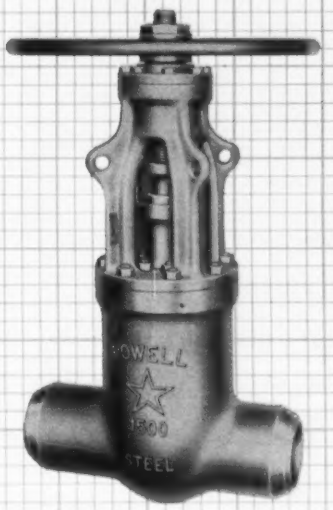


Fig. 11303—Steel Pressure Seal Gate Valve for 1500 pounds W.S.P. The higher the pressure within the valve the tighter the seal at body-bonnet joint. 600, 900, 2500 pound valves can be furnished.

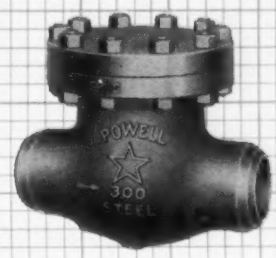


Fig. 3061A WE - Newly designed Steel Swing Check Valve for 300 pounds W.S.P. Has straight flow through area when disc is in wide open position.

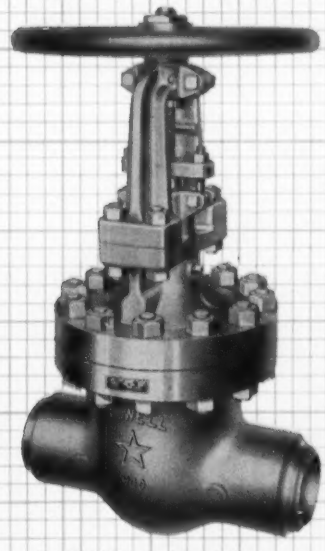


Fig. 9003 WE - Steel Gate Valve for 900 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge disc. Steel valves are available for pressures from 150 through 2500 pounds.

Fig. 512—Small Bronze Gate Valve for 150 pounds W.S.P. Inside screw non-rising stem. Solid wedge disc. Can also be supplied with flanged ends.

Fig. 1444—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. Outside screw rising stem and yoke, double wedge disc. Also available with solid wedge disc.

NO MATTER WHAT your flow control requirements, Powell offers more kinds or types of valves, available in the largest variety of metals and alloys. Powell distributors, located in all principal cities, maintain inventories to fill almost any need. For special engineering problems, write direct to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

Program Control Panel used at Delaware Station, Philadelphia Electric Co. to automatically start and stop their W&T Slime Chlorination System.

HOW W&T CHLORINATION

controls slime in power generating plants

The Philadelphia Electric Co. has W&T chlorination equipment installed in their steam-electric generating stations to prevent slimes from fouling the turbine condensers and lowering the efficiency of the units. Maintaining cooling efficiency saves enough fuel to more than pay for the treatment.

Chlorination is controlled from a W&T Program Control Panel like the one pictured. Operators preselect chlorine dosage and treatment times. Chlorination is started and stopped automatically in accordance with the preselected schedule. The result is positive slime control without requiring personnel to supervise each treatment and without the expense of chlorinating continuously.

For information about W&T Slime Control Systems write for Bulletin CD-42.

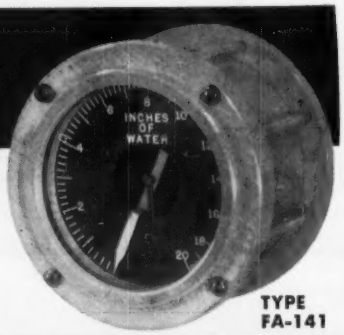
WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

PRECISE PRESSURE MEASUREMENT

. . . For Low Pressure Work

Ranges: 0—10 inches water (min.) to 0—30 inches mercury (max.). Intermediate ranges available.
Accuracy: 1/300 of full scale
Sensitivity: 1/500 in *all* ranges
Dial Size: 2¾" or 6" diameter



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Write for Publication No. TP-27-A

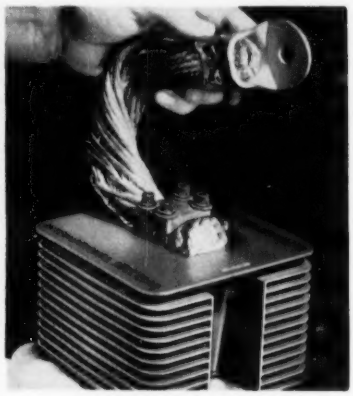
WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, N. J.

Equipment news

Begins on page 158

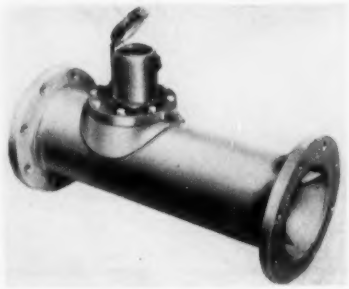
ated by ¼-hp 1750-rpm motor. A 50:1 reduction worm-gear assembly operates crosshead drive mechanism to move piston injectors. Output may be preset to inject from a few oz to 40 gal in a 24-hr period with one injector head.—*Texsteam Corp, Div of Vapor Heating Corp, 320 Hughes St, Houston 11, Texas.*



Rectifier junctions

422 • Designed for application to heavy-duty electrochemical, metal-refining and similar installations requiring high current at low voltage, unit is said to provide efficiency of 98.9%. Cast aluminum housing removes heat from all-welded hermetically sealed junction at optimum rate, according to manufacturer. Unit comes in six types, with input voltages from 20- to 66-v rms.—*International Rectifier Corp, El Segundo, Calif.*

For more details on these items, use post cards p 165. Identify your request with item number.

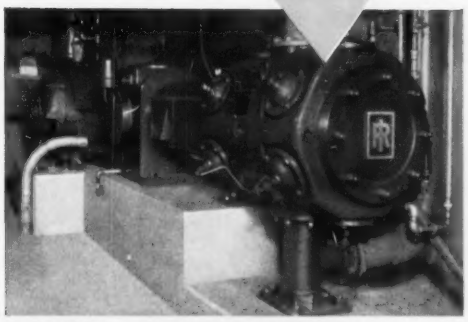


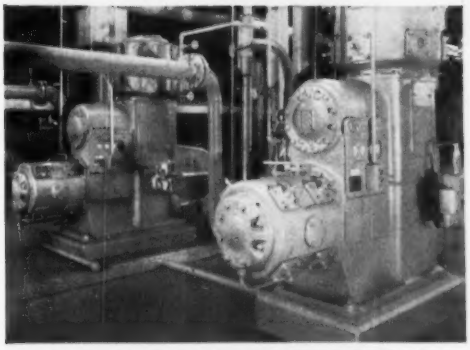
Main-line meter

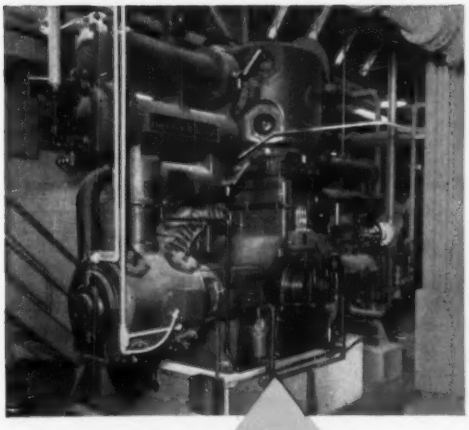
423 • Unit incorporates powerful radial magnet molded as part of propeller hub. Companion magnet on drive shaft of meter permits motion to be transmitted to sealed transmis-

THE RIGHT COMPRESSOR

for EVERY Power Plant application







Compressors designed
FOR THE JOB operate
most dependably and economically

for INSTRUMENT AIR
ESH-NL Compressors 20 to 150 hp

Ingersoll-Rand heavy-duty Class ESH compressors with NL (non-lubricated) cylinders meet the most exacting instrument-air requirements—dependability, continuity of service and *oil-free air*. The NL piston is fitted with graphitic-carbon supporting and pressure rings, requiring no oil, grease, water or glycerine for lubrication.

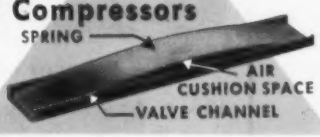
for GENERAL SERVICE AIR
XLE Compressors 125 to 350 hp

The XLE is a two-stage, electric-driven, heavy-duty compressor. The proven design, using full-floating aluminum bearings, and thru-frame air flow with packaged intercooler, makes the XLE a logical choice wherever a dependable supply of service air is required. Maintenance and operating costs are low. The machines are easy to install, requiring only a minimum of foundation because of their excellent running balance.

for SOOT BLOWING
TVH Compressors 200 to 450 hp

These three-stage compressors have been specifically developed for heavy-duty soot-blowing service at pressures from 350 to 500 psi. Inverted "T" design, with self-contained intercooling assures high overall efficiency, low discharge temperatures and smooth running balance.

Only I-R Compressors



have CHANNEL VALVES

I-R Channel Valves are known the world over for their high efficiency, remarkable durability, long service life and freedom from maintenance. On opening, the valve channel lifts upward against spring pressure—trapping a cushion of air between the channel and spring. This exclusive air-cushioned design cuts impact shocks, reduces wear and assures quiet operation.

NL Channel Valves for non-lubricated cylinders are the only valves designed specifically for this service, with no metal-to-metal sliding or rubbing surfaces, assuring sustained high efficiency and longer valve life.

For a quick solution
to any compressor problem,
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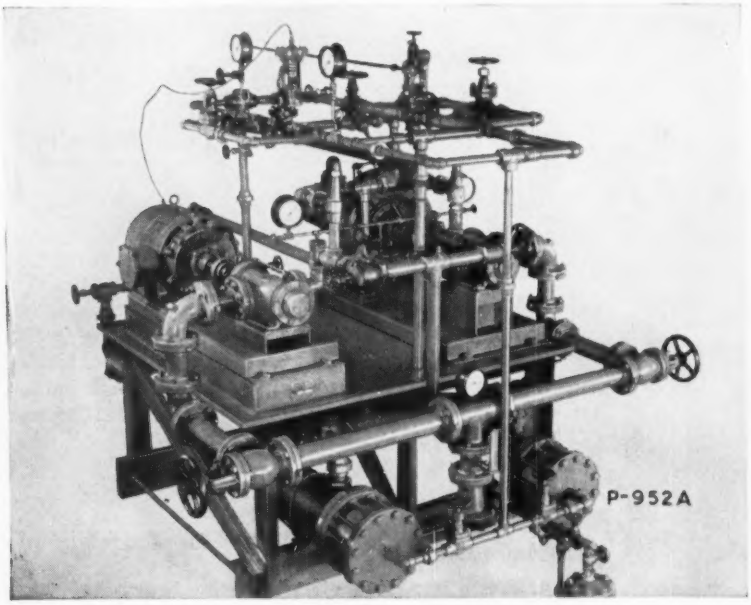

P-952A Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

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FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

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Equipment news

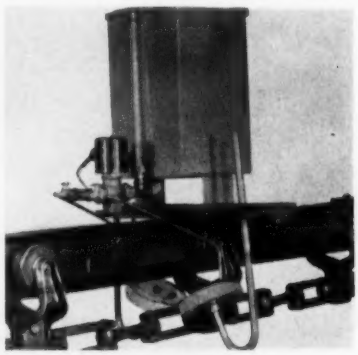
Begins on page 158

sion from propeller to register. Available in 4-in. to 24-in. sizes, working pressures Standard 150 or 250 psi. —*Sparling Meter Co, 225 N Temple City Blvd, El Monte, Calif.*

Molded transformers

424 • Unit is made of epoxy resins, designated type *CPE*. Designed for indoor or outdoor metering applications, transformers can be used with watthour meters and in other applications where high accuracy at low burdens is required. — *Standard Transformer Co, 143 Dana St, Warren, Ohio.*

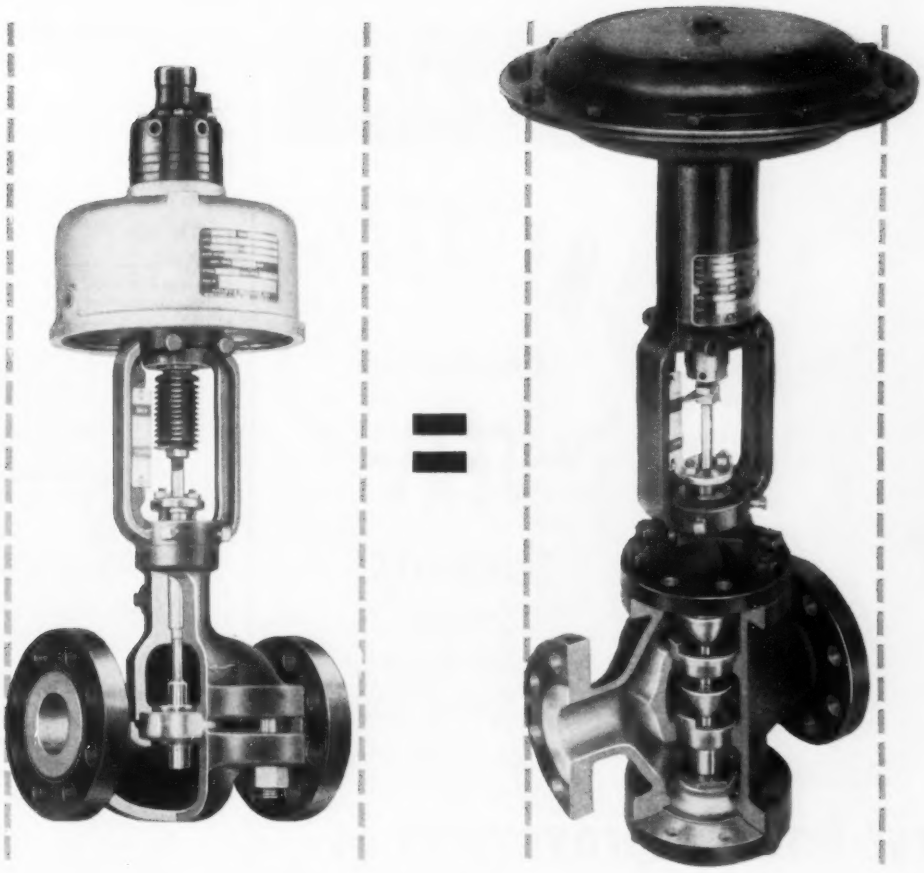
For more details on these items, use post cards p 165. Identify your request with item number.



Conveyor oiler

425 • Automatic oiler for conveyor chain links and pins is said to apply an even film of oil by direct contact of oil-carrying felt rollers. There is no mist, spray or drip, according to maker.

Rollers apply oil film to each side of top of chain. Independent hinging maintains equal roll pressure de-



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reduce costs . . . increase valving flexibility

With face-to-face dimensions to I.S.A. standards, K&M split body valves are interchangeable with K&M regular globe-body diaphragm valves (and with all standard makes of diaphragm valves).

This *exclusive* feature of the K&M split body design enables you to make significant reduction in your plant inventory investment of replacement valves. It gives you highly desirable flexibility.

Additional flexibility is provided in the K&M split body valve itself. Interchangeable, unitized construction makes it possible to develop 432 different valve combinations from a single split body.

In a matter of minutes you can make the body reverse or direct-acting; switch the operator to dome, diaphragm, or handwheel; change the seat ring to one of several types; recharacterize by selecting a different plug; substitute the replaceable, rotatable flanges; convert from globe to angle type.

The K&M split body valve fits your existing piping and fits your budget.

One more plus . . . K&M split body valves have the largest C_V offered in split body construction . . . more flow for your money.

Write for Catalog 132 completely describing the valve that brings the split body idea to its fullest development.

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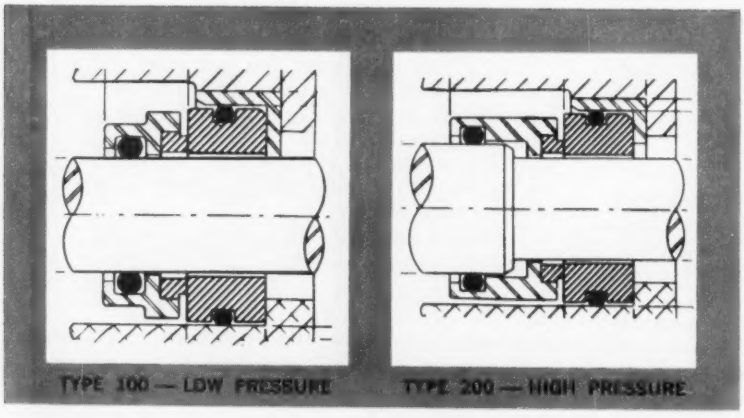

SIMPLE TO INSTALL — Self positioning — Does not require dismantling of pump. Magnetic attraction of sealing and mating rings eliminates use of springs. Up to 18 parts eliminated. Sealing contacts always positive and even. Seal is so thin it will fit in shallowest of boxes.

Complete brochure gladly furnished on request.

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America's Oldest Manufacturer of Mechanical Packings

Equipment news

Begins on page 158

spite swaying of conveyor-chain in motion. Solenoid valve automatically starts and stops oil flow as conveyor starts and stops.—*Olsen Manufacturing Co, 638 S Rochester Road, Clawson, Mich.*

For more details on these items, use post cards p 165. Identify your request with item number.

Alpha, beta-gamma monitor

426 • Instrument provides simultaneous measurement of both alpha and beta-gamma activity of airborne particles as they are collected. Exact amount of radioactivity of sampled area can be read immediately, without any delay for interpretation, evaluation of readings.

Designated *AM-33*, unit can be used wherever airborne-particulate radioactivity may be a problem—at reactor sites, in research laboratories and industrial plants using radioisotopes. Basic detector is a gas-flow proportional counter with a thin mylar window. Unit combines a detector, amplifier, discriminator, anticoincident circuit, counting ratemeter, high- and low-voltage power supply, alarm system and continuous-recording unit. Operation is automatic and continuous for up to one month, according to manufacturer.—*Nuclear Measurements Corp, 2460 N Arlington Ave, Indianapolis 18, Ind.*

What made Thief River Falls decide on STANDARD D&G Oil

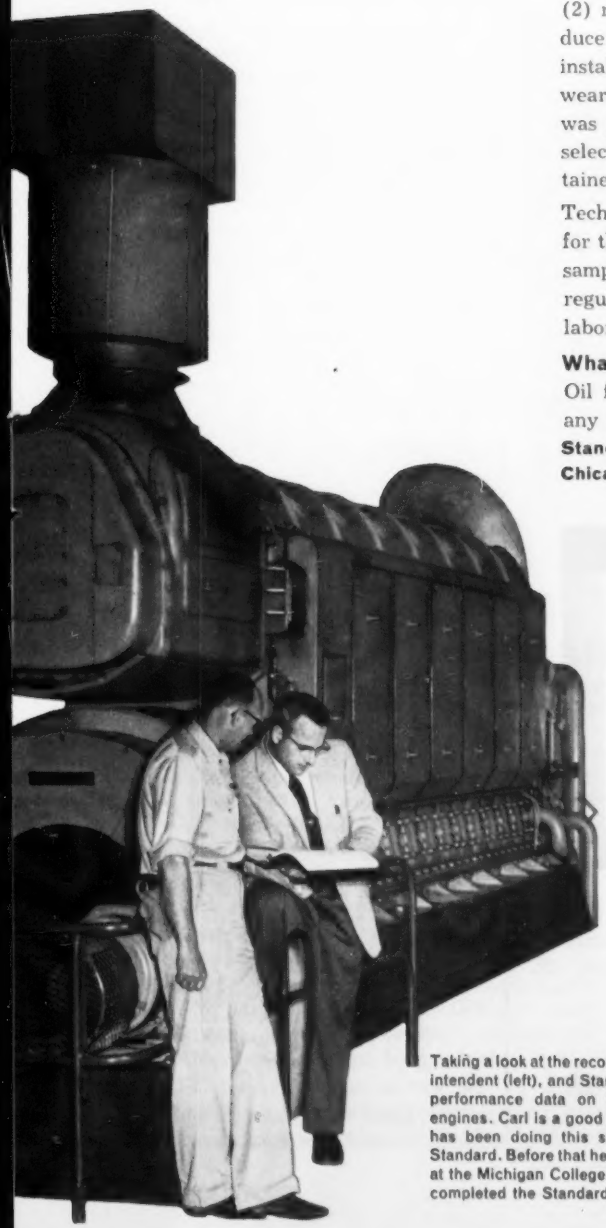
Two Fairbanks-Morse OP engines turn in top-rated performances with this lubricant.

The situation: In January of 1952 the Thief River Falls, Minnesota, municipal light plant put into service a 10-cylinder, 1,600 hp. Fairbanks-Morse opposed piston engine. In November, 1955, a 1,900 hp. Fairbanks-Morse OP engine was added.

What was done: The power plant management discussed lubrication requirements with Standard Oil lubrication specialists. Because of the evidence that STANDARD D&G Oil, with its higher additive level, could (1) reduce ring and wall wear, (2) reduce ring sticking, (3) increase bearing life and (4) reduce engine deposits, this oil was selected for the first engine installed. After 22,000 hours, inspection showed little or no wear. Small wonder then that when the second OP engine was put into service in 1955, STANDARD D&G Oil was again selected. After 7,500 hours, similar performance is being obtained on the newer engine.

Technical service performed by Standard Oil men pays off for the power plant management. Standard men take frequent samples for field inspection of oil condition. Other samples are regularly taken for transmittal to Standard's Whiting, Indiana, laboratory for complete analysis.

What you can do: Get more facts about STANDARD D&G Oil from the Standard Oil lubrication specialist near you in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

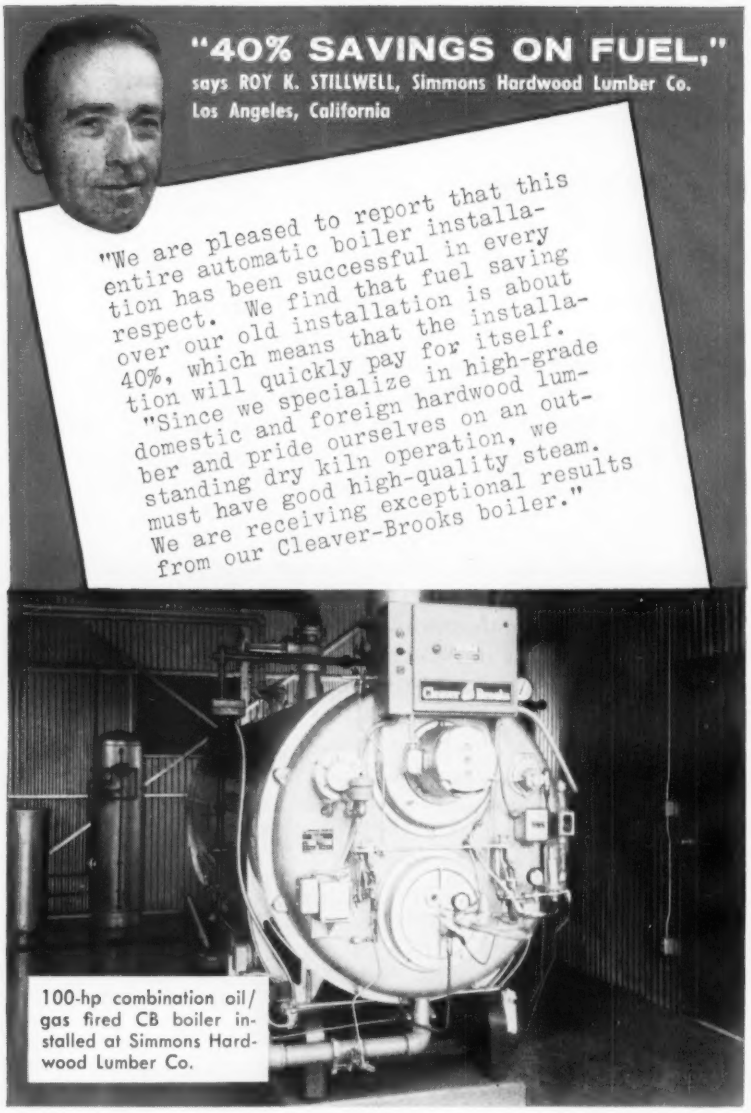


Taking a look at the record. Morris L. Owen, plant superintendent (left), and Standard Oil's Carl Klenner look at performance data on the two Fairbanks-Morse OP engines. Carl is a good one to talk things over with. He has been doing this sort of work for 10 years with Standard. Before that he received an engineering degree at the Michigan College of Mining and Technology and completed the Standard Oil Sales Engineering School.

Quick facts about STANDARD D&G Oil

- Made from highest-quality solvent-refined stock.
- Contains additives which impart superior detergent-dispersant and anticorrosion properties.
- Antifoaming.
- Oxidation-resistant.
- Recommended for use (1) with economy fuels (2) in extreme-load and/or low-temperature service.

You expect more from STANDARD *and get it!*


"40% SAVINGS ON FUEL,"
says ROY K. STILLWELL, Simmons Hardwood Lumber Co.
Los Angeles, California
"We are pleased to report that this entire automatic boiler installation has been successful in every respect. We find that fuel saving over our old installation is about 40%, which means that the installation will quickly pay for itself.
"Since we specialize in high-grade domestic and foreign hardwood lumber and pride ourselves on an outstanding dry kiln operation, we must have good high-quality steam. We are receiving exceptional results from our Cleaver-Brooks boiler."
100-hp combination oil/gas fired CB boiler installed at Simmons Hardwood Lumber Co.

For process steam economy . . .

Install a packaged CB boiler

CB boiler four-pass design with forced draft is the most efficient combination to transmit heat to boiler water. Forced draft blower provides correct amount of air for complete combustion, eliminates the need or cost of a high, expensive chimney. Combustion gases are forced at high velocity through the four passes, literally scrubbing heat from the flame. Result: lower fuel costs.

Five square feet of heating surface per boiler hp is another reason why CB boilers give you longer service life with less maintenance. Every CB boiler is guaranteed to operate at a minimum efficiency of 80%.

Each Cleaver-Brooks self-contained boiler is a complete package. Fully factory tested, it's ready for installation, service connections and operation. No make-ready delays . . . no extra parts needed.

A trained technician starts your CB boiler, adjusts it for your specific needs, and trains your attendant in care and maintenance.

Available in 19 sizes, 130 models, 15 to 600 hp — steam or hot water, gas, oil, or combination oil/gas fired.

For more facts on the self-contained CB boiler, contact your dealer or write: Cleaver-Brooks Company, Dept. D, 301 E. Keefe Ave., Milwaukee 12, Wisconsin.

Cleaver Brooks®

ORIGINATORS OF SELF-CONTAINED BOILERS

Marmaduke

Continued from page 148

"'Boys, your problem's solved,' yelled Jed soon as he saw me. 'If my old shipmate Marmy can't unravel your puzzle, I'll buy a round of drinks and maybe blow all of us to a fried chicken dinner besides.'

"After shaking hands, we sat down to a table to wet our whistles while Jed and Niel briefed me on their headache.

"Carter explained that he had bought a new 500-hp diesel engine. She was on one of the Garaway trucks, right next to its foundation in the new icehouse. Problem was to get the heavy diesel from the truck down to the foundation without a lot of expensive rigging and handling.

"'You can't tie up that heavy truck longer than this evening or I'll have to charge you $50 a day,' warned Garaway, looking at Carter. 'I contracted to haul that engine from the railroad flatcar to your place. There was nothing in our agreement about lowering it over those foundation bolts, onto your foundation. Hell, that's a professional rigger's job. Besides, I don't have the rigging gear to do it and I need that truck tonight to haul a job across the river. If you don't take her off by noon, we'll rig up a ramp and slide her down onto the ground. That'll keep my end of the deal.'

"'Let's be reasonable,' came back Carter. 'Only way I can lower that engine directly over the foundation is to get riggers up here from New Orleans. That'll cost me a small fortune and take time besides. If you slide that engine onto the ground, it'll cost more to lift her up and move her over those holding down bolts than if you lower her the first time,'

"'OK,' exclaimed Garaway. 'OK, just tell me how.'

"'Hold it, boys,' I cut in. 'I'll lower that engine and I don't need any fancy rigging gear, jacks or even a platform or slide. All I need is a a few laborers with wheelbarrows. I promise to have that engine off that truck by this evening. But I'll want $50 for masterminding the job.'

"That stopped the argument. Those three guys stared at me for a minute without saying a word. Finally Carter piped up, 'You mean to say you'll get that 5-ton engine off the

Hall Industrial Water Report

VOLUME 6 APRIL 1958 NUMBER 2

Steam-Electric Power Plants Have to Keep Rolling

If they don't, our whole complex machinery of civilization suddenly dies. Mills go down, office buildings go dark, air conditioning stops—even television is blinded.

Undisciplined water can cause unscheduled outages. That is why upwards of 300 utilities and more than 2500 industrial steam generating plants retain Hall Laboratories to help them avoid water problems and to solve them when they do occur. This is a most important part of Hall's activities on all kinds of industrial water—cooling water, service water, process water, waste water.

Disappearing Phosphate

One summer the operators in a Midwestern utility plant were puzzled by the disappearance of boiler water phosphate residuals over a number of consecutive week ends. Then to their dismay, boiler tubes began to fail as a result of scale formation.

It was obvious to Hall Engineer J. F. Nelson that the boiler feedwater was being contaminated with hard water over week ends, but finding the point of contamination proved difficult. Innumerable samples of feedwater drawn hourly by the operators showed only the usual 0.5 ppm or less of hardness. However, one night when the air conditioning load dropped abnormally because of cooler weather, hardness showed up. It was traced to a small boiler feed pump used only for light loads. Hard water used for sealing was leaking into the pump suction when load was sufficient to reduce the pressure below that of the sealing water.

Diagnosis had been difficult because contamination occurred only with the small pump used when loads were light and only when this pump was operated at full capacity. These conditions were experienced mainly over week ends.

As with most problems, correction was easy once a satisfactory diagnosis had been made. Substitution of condensate for hard water as gland sealing water eliminated the contamination regardless of load.

An Opportune Visit

On a routine visit to a western utility plant Hall Engineer C. L. Fitzgerald found management trying to decide what to do about preparation of makeup water for a new steam-electric unit. The inclination was to use existing evaporators because of a $100,000 price tag on demineralizing equipment. How to pretreat evaporator feedwater was the pressing problem.

The existing pretreating equipment consisted of an old lime-soda plant operated batchwise in the cold. Consideration was being given to costly, extensive repair work on the old plant and to installation of individual chemical feed tanks and proportioning pumps for the evaporators. Fitzgerald agreed that the changes contemplated would facilitate water treatment and improve evaporator feedwater conditions and vapor quality. However, he was quick to propose an alternative which would involve lower capital investment and operating cost.

Fitzgerald's recommendation was to scrap the existing equipment and to replace it with sodium zeolite softeners costing approximately $2000. Two existing tanks could be used for storage of softened water and one chemical tank and proportioning pump would suffice to feed chemicals into the water line to the evaporator preheater. This arrangement would not only produce excellent quality water for the evaporators but it would do so with a minimum of attention and at low cost.

The scheme proposed was not hard to sell to management. Capital expenditure dropped by stages from the first considered $100,000 to a final figure of close to $2000. The daily saving in chemical cost was sufficient to amortize the expenditure in little more than one year.

Why So Much Copper

When a routine analysis disclosed the presence of an unusually high concentration of copper in the recirculating cooling water at a midwestern city light plant, the operators were justifiably alarmed. That the copper was accelerating corrosion of steel was indicated by a steel test strip removed from the cooling water system. Along with severe pitting, the strip showed copper plating.

No copper compound was being used as an algaecide. Furthermore, routine checks showed the pH value of the circulating water to be 8.0, high enough to control corrosion of copper alloy condenser tubes.

Hall Engineer W. E. Pfeiffer reasoned that the copper source had to be the condenser tubes. Perhaps pH control was not really as good as indicated. Upon investigation, he found that the operators, to facilitate acid feeding, had changed the point of application and were feeding intermittently at hourly intervals. Further determinations revealed that while the pH value of the circulating water at the condenser outlet was 8.0 when acid feed was started, during the short period of acid introduction it dropped to 3.0.

With the problem in focus, changes were made to feed acid properly and thus return to normal the copper content of the water and the operator's peace of mind.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

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A Midwest Power Plant engineer made this comment and gave the information below about the operation of their American AC 3-E Rolling Ring Coal Crusher.

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Feed	20% Nut (3" x 1½") 80% Screenings (1½")
End Product	Minus ½"

Performance reports like this are standard on American Crushers. Each crusher is custom-built to suit your requirements. The American performs as an efficient crusher, producing high tonnage at slow operating speeds — saving power and maintenance. The manganese steel shredder rings are reversible for double life, crushing chambers have renewable liners, and housings are sectional for easy accessibility to rotor, and machined for a dust-tight fit. These, and many other features have been developed throughout 50 years of experience.

Our engineers will analyze your reduction problems and make recommendations of the correct size and type of crusher. No obligation, of course. Write for literature, stating your tonnage requirements.

"When you figure costs—the best results come from American Rolling Ring Coal Crushers"

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

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Marmaduke

Continued from page 182

truck and onto the foundation with a handful of darkies and no rigging whatever? And do I understand that you'll just stand around supervising the job without using chain falls, jacks or anything?'

"'You hear right,' I answered, downing a glass of beer.

"'All right, I'll bite,' piped up Garaway, suspiciously. 'How you gonna do it . . . with balloons?'

"'Not balloons,' I answered. 'I'll have your boys build a simple hydraulic jack. Just hand my friend Jed here $50 and give me the men I need. If you won't do that, I'm going back aboard the *Mary Ann* after lunch. Up to you.'

"'It's a deal,' said Carter suddenly. 'Here's the fifty, give it to Mr Surfaceblow if he comes through, Jed.' Then, turning to me, he continued, 'Soon as we leave here, I'll get my four laborers over at the new icehouse to help you. But I've still got to see how they are going to build a hydraulic jack—whatever that is.'

"After lunch the three of us walked over to the new plant. I told Carter to get his men busy hauling blocks of ice out of his storage house because I'd have them build a foundation of ice about 10-feet square over the new diesel foundation.

"'What's the idea,' asked Carter, giving me a fishy look.

"'Simple,' I said. 'After that ice platform is built up even with the truck platform, we'll slide the engine onto it. Then by tomorrow or the next day the sun will turn that ice into a hydraulic jack. That engine will settle onto that new foundation as gently as a hen sitting on her eggs.'

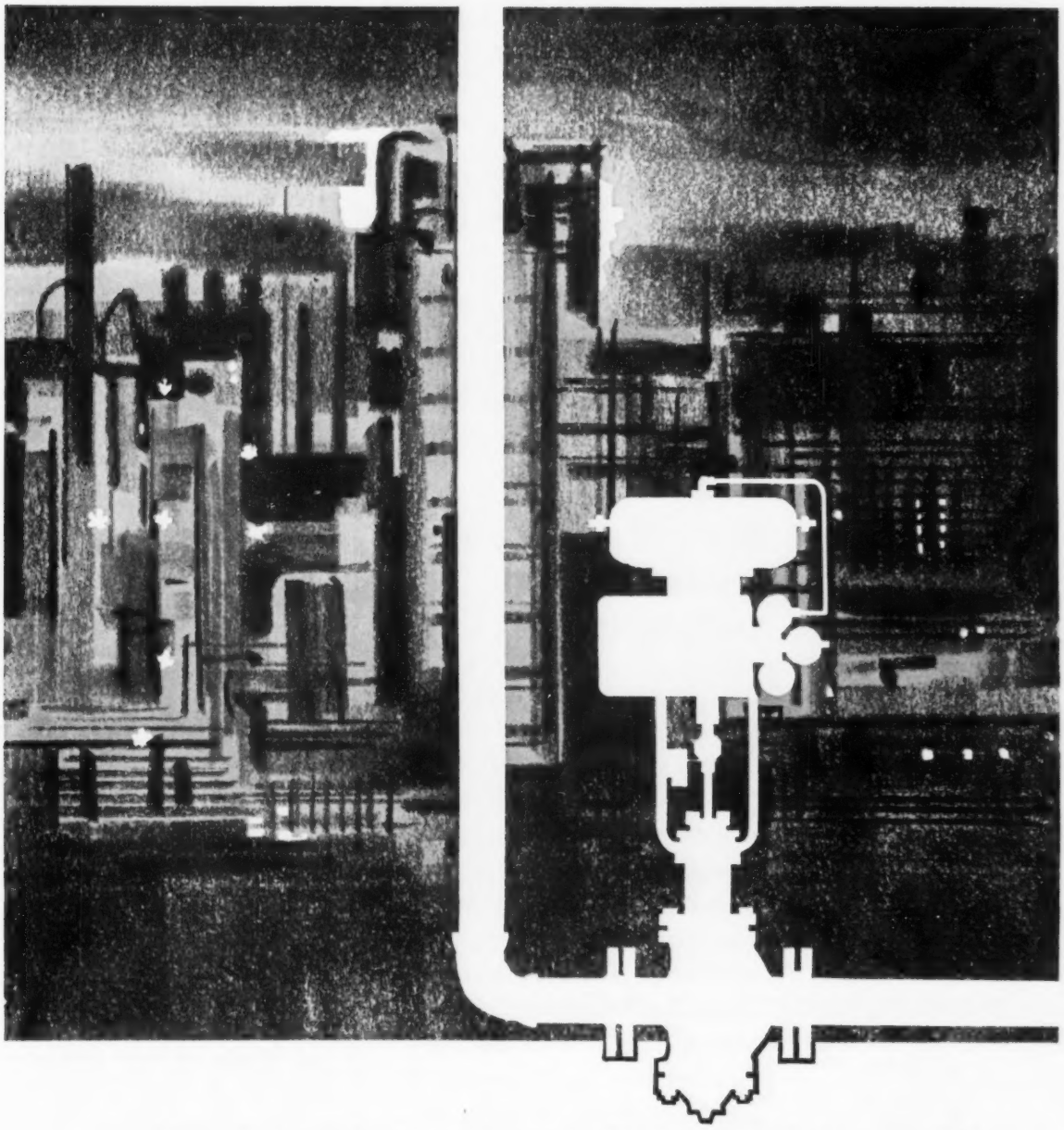
"And that's exactly what happened," wound up Marmy. When I shoved off on the *Mary Ann* three days later, the ice had melted and a mechanic was leveling the engine and grouting her onto the foundation.

—Steve Elonka

Regards to Marmy

Please give my regards to Marmy. His experiences help the young engineers entering the power field. They can gain a wealth of information by spending a few minutes reading his sound-offs. Keep up the good work.

R C Conk, *Newark, N. J.*



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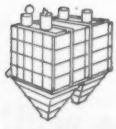

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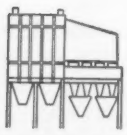

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Power for space

Continued from page 86

The reaction force propels the rocket. Let's study this a bit. A uniform gas pressure acts at right angles on every bit of interior area of the combustion chamber. For any unit area on one wall having a given total pressure there will be an equal area on the opposite wall with an equal pressure acting in the opposite direction.

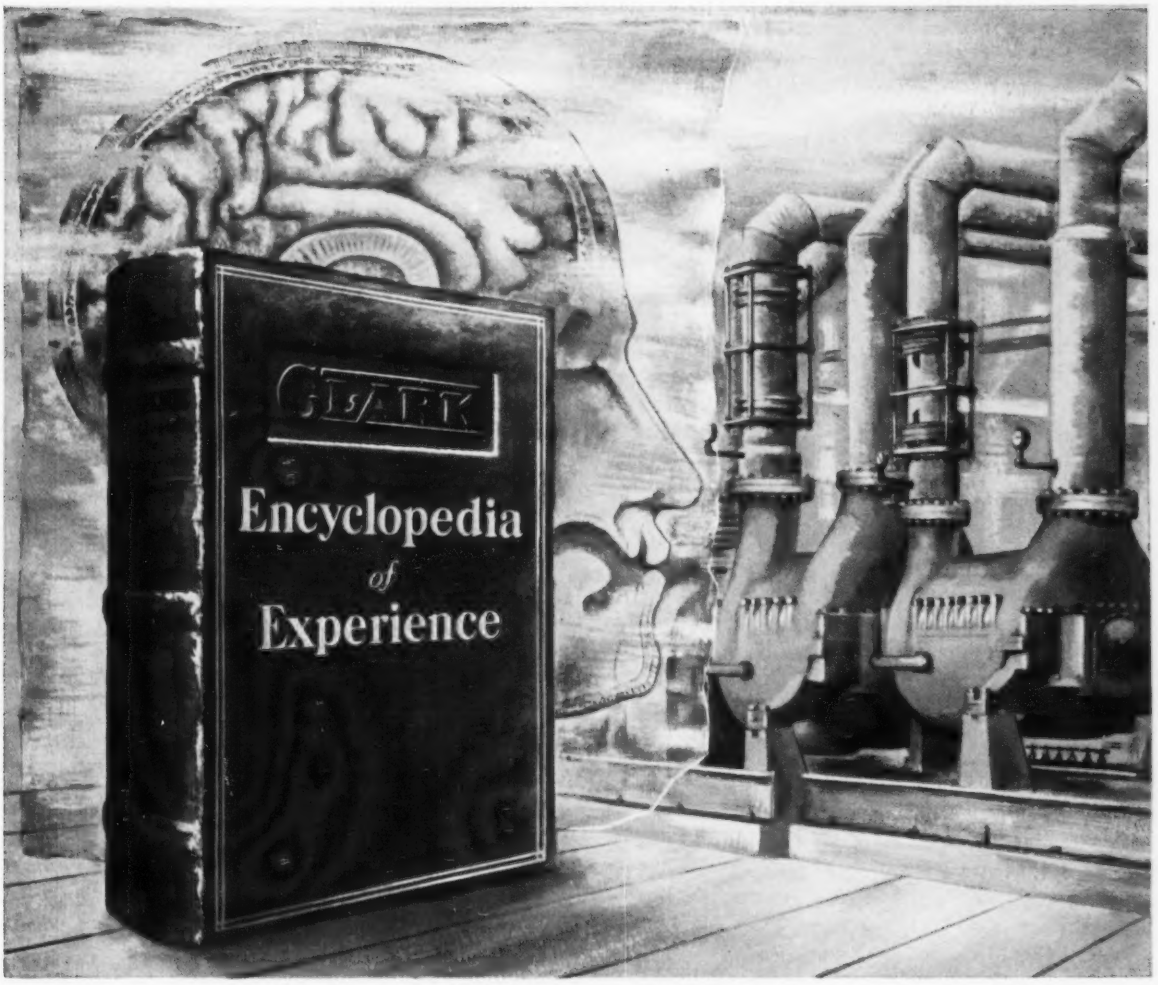
If the chamber were completely closed, Fig. 7*a*, equal and opposing internal forces would act in all directions and exactly balance each other. But making an opening in one wall to let gases escape, removes pressure on that wall at the opening. This removes a force that balanced an opposing force on the facing wall. The remaining *unbalanced force* or reaction propels the entire rocket.

Energy demands. Let's look at the energy needs again. A rocket must use 13,600 Btu for every pound mass thrown into a low-altitude orbit. But good coal (mostly carbon) just about develops this amount of energy per lb of fuel. But in addition, a rocket must carry along *its own oxygen* as well as fuel. So for each pound of carbon in the fuel it must also carry 2.66 lb of O_2, neglecting H_2 in the fuel for the moment. On an overall basis the coal and oxygen can only produce 13,600/3.66 = 3710 Btu *per lb of propellants.*

As if this isn't discouraging enough we must remember that the rocket itself—combustion chamber, pumps, turbines, casing, controls, fuel tanks —weighs something; this is a deadload. Finally, this rocket must carry a payload, in our case a satellite. Deadload and payload must be hurled into space together. Rocket engineering has progressed to the point that in large rockets for every 90 lb of propellant we can carry 10 lb of combined deadload and payload.

But using carbon for fuel would only give us 3710 × 0.9 = 3340 Btu per lb of loaded rocket at launching to work with. We need more than 13,600 Btu per lb of loaded rocket; allowing for deadload and payload we need 13,600/0.9 = 15,120 Btu per lb of loaded rocket to get to orbit speed.

Let's look at hydrogen with its heating value of 62,000 Btu per lb. To burn one lb of hydrogen we need



Behind every Clark Compressor and Gas Turbine is an **ENCYCLOPEDIA OF EXPERIENCE**

The performance of a manufacturer's products over the years reflects the knowledge and skills of their builder. This compendium of engineering wisdom at Clark Bros. Co. can best be described as the Clark *encyclopedia of experience.*

The field performance of Clark's heavy duty compressors, and the engines and gas turbines which drive them, has earned for Clark the reputation of building "precision by the ton". Clark engineering, supported by the Clark *encyclopedia of experience,* is responsible for this performance and precision.

From Clark's vast experience, the needs of industry for ever better machines have been met. From it have come the many Clark contributions to the petroleum, chemical, and process industries.

It was the Clark *encyclopedia of experience* which was responsible for: the balanced/opposed principle for compressors... the world's first 2-cycle turbo-supercharged gas-engine-driven compressors and the oil seal that made centrifugal compressors practical.

These are but a few of the "firsts" and of the developments, plus the precision and performance, with which Clark engineering is credited. All stem from the Clark *encyclopedia of experience.*

If you use air or gas, you can get full information about Clark products to serve your industry by calling your nearby Clark engineer. Or write Clark Bros. Co., 2501 Lincoln Avenue, Olean, New York.

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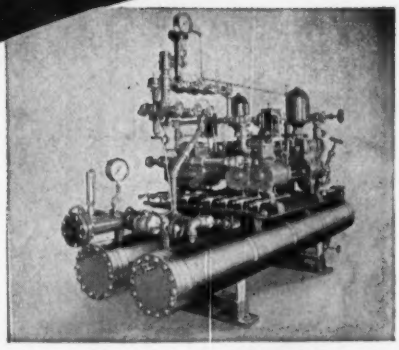
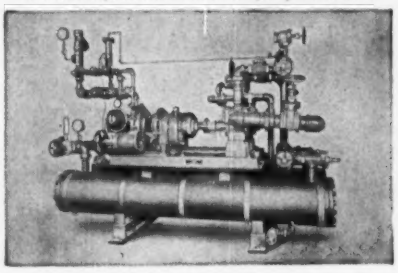
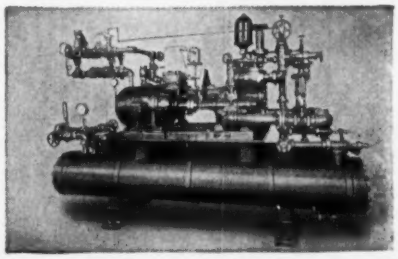


Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. M. at 250 lb. pressure with either pump or heater.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.

BULLETINS ON REQUEST

OB-53 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK 6, N. Y.

Power for space

Continued from page 186

8 lb of O_2. So each pound of propellant develops 62,000/9 = 6890 Btu—far short of the 15,120 Btu we are looking for. Hence, the push for exotic fuels we hear so much about today—but practically all of which is classified information.

Multistaging. The solution to overcoming our weak fuels was proposed over 50 years ago—multistage rockets, Fig. 4. Suppose that for each stage of a 3-stage rocket, 90% was propellant weight, 5% was deadload and 5% payload. Relative weights, and energies given the payloads, are:

Stage	*1*	*2*	*3*
Total lb	1000	50	2.5
Propellant lb	900	45	2.25
Deadload lb	50	2.5	0.125
Payload lb	50	2.5	0.125
Btu per lb	6200	12,400	18,600

The first-stage rocket accelerates its payload consisting of the second and third stages and the satellite until all its propellants are consumed (burnout). For hydrogen propellant this gives a speed corresponding to a kinetic energy of 6890 × 0.9 = 6200 Btu per lb of payload and deadload.

At the instant of first-stage burnout the second-stage rocket fires and continues accelerating itself and payload (third stage) until it has added another 6200 Btu per lb energy for a total of 12,400 Btu per lb payload.

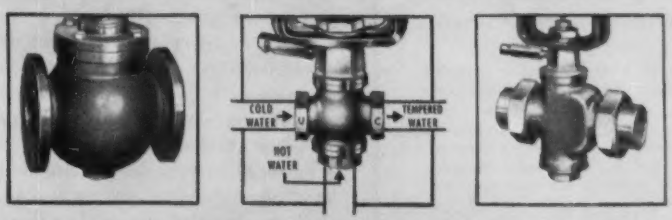
At the instant the second stage burns out the third-stage rocket fires. At burnout the third stage has added another 6200 Btu per lb energy as increased speed for a total of 18,600 Btu per lb payload. The payload then has an energy well above the 13,600 Btu per lb needed for a zero-altitude satellite. Fig. 6 shows that for 18,600 Btu per lb we could loft the satellite into an orbit at 2500-miles altitude.

The weight proportions to achieve this are staggering—we need a 1000-lb rocket of which 947 lb is propellant to launch a 0.125-lb load, a weight ratio of 8000:1.

Let's compare this to what we need to travel 2500 miles on our globe in a 4000-lb automobile. At 15 miles to the gallon of gasoline we need 1170 lb of fuel, but the car carries only a maximum of about 140 lb with it any one time—refueling along the way. During the trip, the car en-

POWERS No. 11 Self-Operating TEMPERATURE REGULATOR

One of Powers many controls. It automatically hold temperature constant at the right point and prevents losses caused by wasteful OVER-heating.

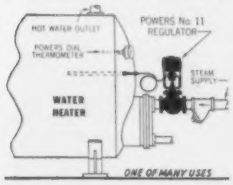


Various Valve Bodies and Inner Valves are available. Single and Double Seat Valves thru 2" have rugged bronze bodies with bronze union connections for quick, easy installation. For further information write for Bulletin 329.

(c33r)

Why It Gives BETTER CONTROL and Saves More Money

Often repays its cost 3 to 6 times a year when used on:



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When you specify or buy a Powers No. 11 Regulator you can be sure that its performance will confirm the wisdom of your choice. Check its Quality Features –

- **Bellows has 50% more power** than used in the majority of regulators. The heart of a self operating regulator is its bellows. Powers with its 50% greater effective area gives better control and its durable 2 ply bellows outlasts ordinary single ply.
- **Powers New 590-LONG-LIFE Valve Packing** marks an important milestone in the reduction of maintenance. It has a low friction factor and outlasts others by a big margin.
- **Valve stem lubricator** with silicone grease aids easy movement of highly polished stainless steel valve stem and reduces drying out of packing.
- **60° F. Temperature ranges.** Control system is sensitive to temperature changes within 1 to 2° F.
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has a big easy to read 4" dial thermometer. It gives a quick check of controlled temperature and provides an accurate guide for adjusting regulator.

A feature originated by Powers in 1930.

- **Powers Nationwide Service and 24 Hour Delivery** in the U. S. and Canada are important time and money saving advantages.

If you have a temperature control problem, call your nearest Powers office or write us direct.

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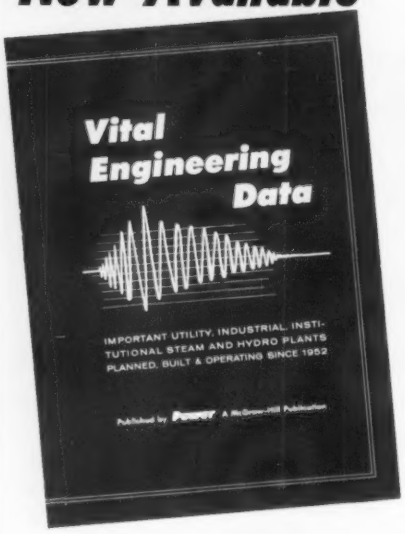
Automatic Temperature and Humidity Control
Since 1891

Now Available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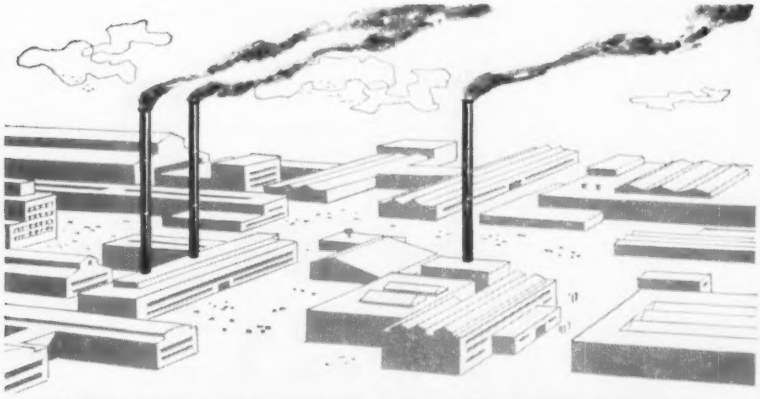

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Power for space

Continued from page 188

gine gobbles up about 17,900 lb of air to get the 4100 lb of O_2 it needs to burn the gas and immediately spews it out as exhaust.

If the car carried all its fuel with it at one time it would have a weight ratio of 0.29:1. If it carried all its propellants, gasoline and O_2, the ratio would be 1.32:1; compare with the 3000:1 for the rocket. At the end of 2500 miles the car would stop dead; but the rocket payload travels forever at 14,000 mph.

The energy problems of space travel, as well as the environment, needs a viewpoint entirely different from anything we use in our earth-bound activities.

Motor design

Continued from page 104

later date, only the master and a few other logical subroutines are modified to change program's entire course. Also, other programs requiring same fundamental calculations, but accomplishing entirely different results, are coded simply by providing a new master program.

Optimizing design requires solution of a set of nonlinear inequalities and no mathematical techniques have been developed to obtain an explicit solution. Many of the variables are not continuous functions and any method that considers them as such is approximate. The Westinghouse program employs a technique similar to that used by a designer. The designer picks a setup in the design area with hopes that his first choice will be a good one; and his ability to make satisfactory estimates is based on his experience over a number of years on many different design problems. The computer purposely starts out in the fringe areas. All of its decisions are based on design calculations before the final design with each combination of materials is determined. Further, the selection of materials is not left to judgment before the designs are completed. An optimized design is made for all combinations to be considered. This means materials ultimately selected are the ones that have already been proved to give the best design.

As computers take over more

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These five basic factors assure you that the Ljungstrom Air Preheater will give exceptionally long periods of uninterrupted availability:

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3. **INSPECTION PORTS.** You can see for yourself, at any time, the condition of the heating surfaces.

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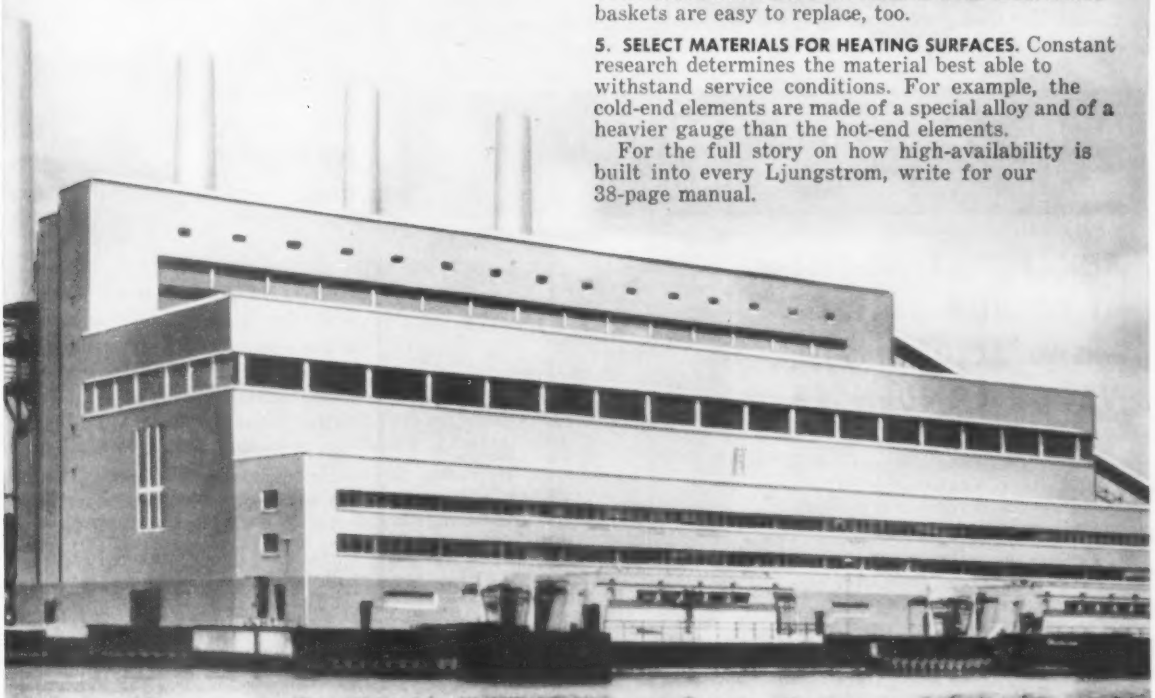
For the full story on how high-availability is built into every Ljungstrom, write for our 38-page manual.



The Air Preheater Corporation 60 EAST 42nd STREET, NEW YORK 17, N. Y.

LOCKETT FUEL OIL PUMPING AND HEATING SETS

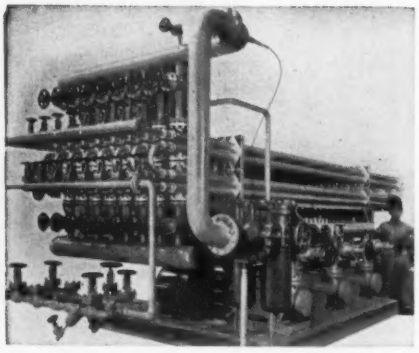


Photo shows one of two, High-Pressure (1000 PSIG) Units being furnished for a Public Utility in the Southwest . . . 3 electrically-driven screw pumps and multiple arrangement of Griscom-Russell Twin G-Fin Heaters handle 230 GPM of heavy fuel oil. Equipped with: Strainers, Temperature and Pressure Controls.

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Motor design

Continued from page 190

production work in design sections, nature of engineer's work changes. Ultimately, each line of apparatus will have its own digital-computer program, and its development will be the function of the design department. Designs for specific orders are made by the computer itself and no longer do large backlogs of orders pile up during periods of peak sales. Engineering data to the purchaser is not delayed by the number of orders on hand.

There are numerous areas where this program is improving operations through statistical studies. Many sales, engineering and manufacturing questions are being answered that will provide better motors for every user.

My biggest boner

Back in 1928 I was doing electrical work in an industrial plant. My helper was a most careless fellow. We had just rebuilt and rewired an Armstrong starter of 100 hp.

My helper wanted to solder the lugs so I asked "OK. Tell me how?"

He recited very faithfully, "Peel the lead ends, don't mar or mark them, put on safety goggles, use tongs, heat solder in pot, warm the ladle, dip ends and lugs carefully so solder won't splash, warm the lugs and ends of leads before filling lugs with solder, don't cool same, hold same until set."

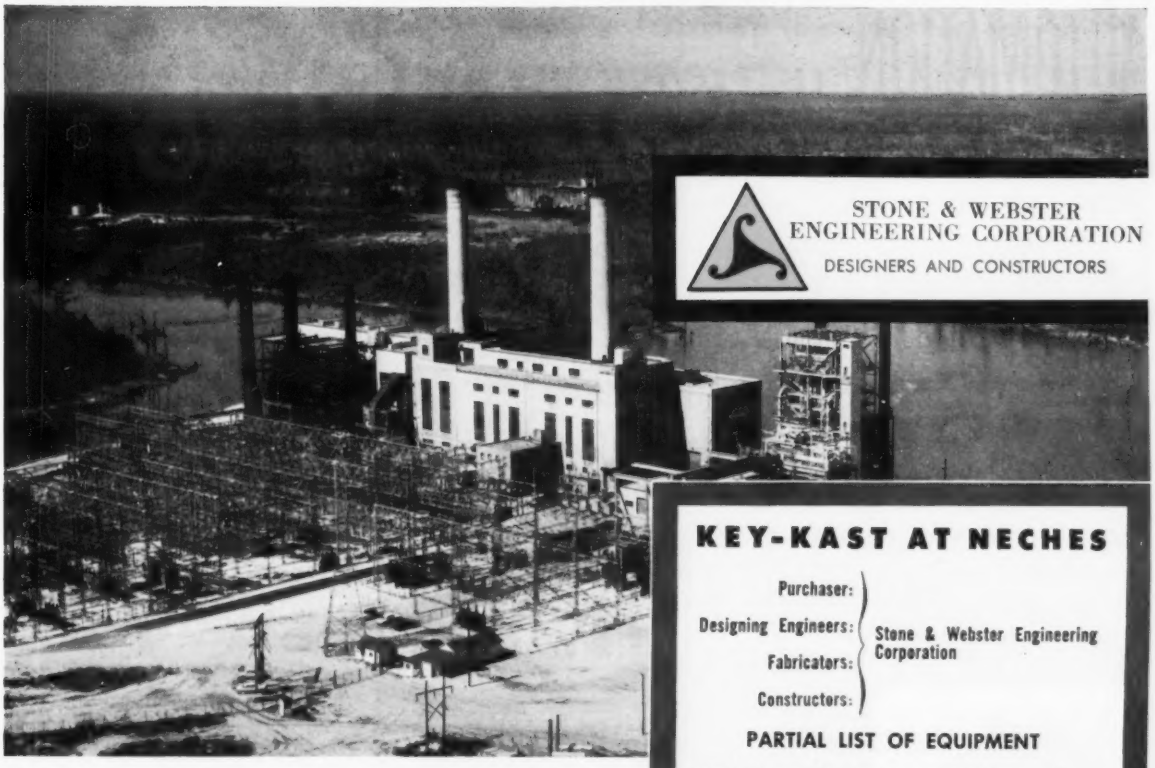
I went out to pick up some of the things I needed to mount the starter. Returning to the building, about one-half hour later, I ran into the chief safety engineer. He was leading my helper—the goggles in his hands were covered with solder.

"What happened?" I asked.

"Oh, I forgot to warm the ladle," was his answer. But the safety goggles saved his eyes.

Here's a good safety moral. You can't put hot things and cold things together. Warm or cool them slowly.

C G HOWARTER, *Canton, Ill.*



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KEY-KAST Fittings are designed by specialists in fluid flow to give you the most desirable shape and longest lasting steel alloys to move your lading safely and efficiently. Available in all standard shapes, sizes and schedules . . . or especially designed to meet particular conditions of pressure, temperature and lading.

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Material: 12¾" x 9.3" O.D. 2¼% Chrome, 1% Moly, ASTM A-217 Grade WC9
Temperature: 1000° F.
Pressure: 1695 psig
Service: Main Steam

KEY-KAST 90° Welding Wye

Material: 18" x 12¾" x 12¾" O.D. 2¼% Chrome, 1% Moly, ASTM A-217 Grade WC9
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Pressure: 550 psig
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Temperature: 1000° F.
Pressure: 1695 psig
Service: Main Steam

KEY-KAST 90° Welding Wye

Material: 12¾" x 9.3" x 9.3" O.D. 2¼% Chrome, 1% Moly, ASTM A-217 Grade WC9
Temperature: 1000° F.
Pressure: 1695 psig
Service: Main Steam

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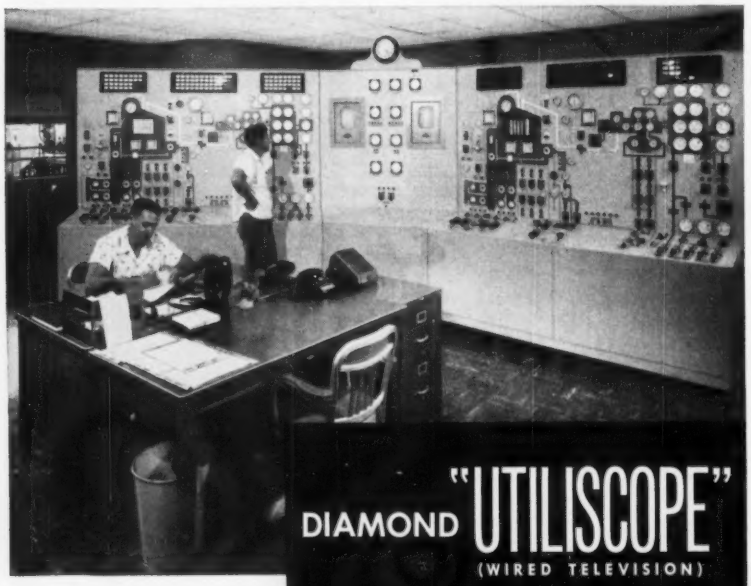

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I-c engines

Continued from page 101

of this, 99.1 Btu goes to the flywheel to be stored for compression of the fresh charge during the next cycle. Finally 206.1 Btu leaves the engine as mechanical shaft work—this is the useful product of the original 546 Btu input from the fuel.

Fig. 4 gives the energy-flow analysis from the standpoint of the individual strokes of the reciprocating engine. Most engines have several cylinders working on the same shaft developing a practically continuous power output. So we can regard an i-c engine as a continuous flow machine. With this idea we can develop the energy-flow diagram in Fig. 5. Here we see the 546 Btu fuel input distributed to cooling water, exhaust heat and net work output. The compression work merely circulates between cylinder and flywheel without contributing directly to net work output. We know, of course, the engine couldn't work without this internally circulating energy.

Next part covers engine throttling, supercharging and actual engine performance—in an upcoming issue.

Welding

Continued from page 95

tion from a low-energy input. So it seems reasonable to expect that increased welding energy input will give a higher joint strength for manual welding approaching or equaling that of the machine-welding process.

Distortion and welding energy input data are given in the table on page 95. The permanent set of the tube sheets from swaging and rolling in Section III isn't as consistently directional as in Section II.

Section II swaging produced negative distortion in all four samples. But only six out of eight samples in Section III are negative. One shows no distortion and the remaining sample is positive.

This lack of complete agreement is probably caused by our method of holding tube sheets for swaging in Sections II and III. It is also caused by differences in the number and intensity of hammer blows used by mechanics to perform the operation.

Tube sheets in both Sections II and III are extremely flexible. Swag-

You get MORE CAPACITY with a FANMIX BURNER

Increase Boiler Ratings On Present Or Planned Equipment

In all types of Coppus-Dennis FANMIX Burners — straight gas or combination gas-oil — we utilize the energy of the fuel under pressure to drive the burner fan and deliver air in the proper proportion to the fuel flow. This exclusive "pinwheel action" *mechanically* mixes fuel and air in exactly the right proportions for truly radiant, non-luminous heat.

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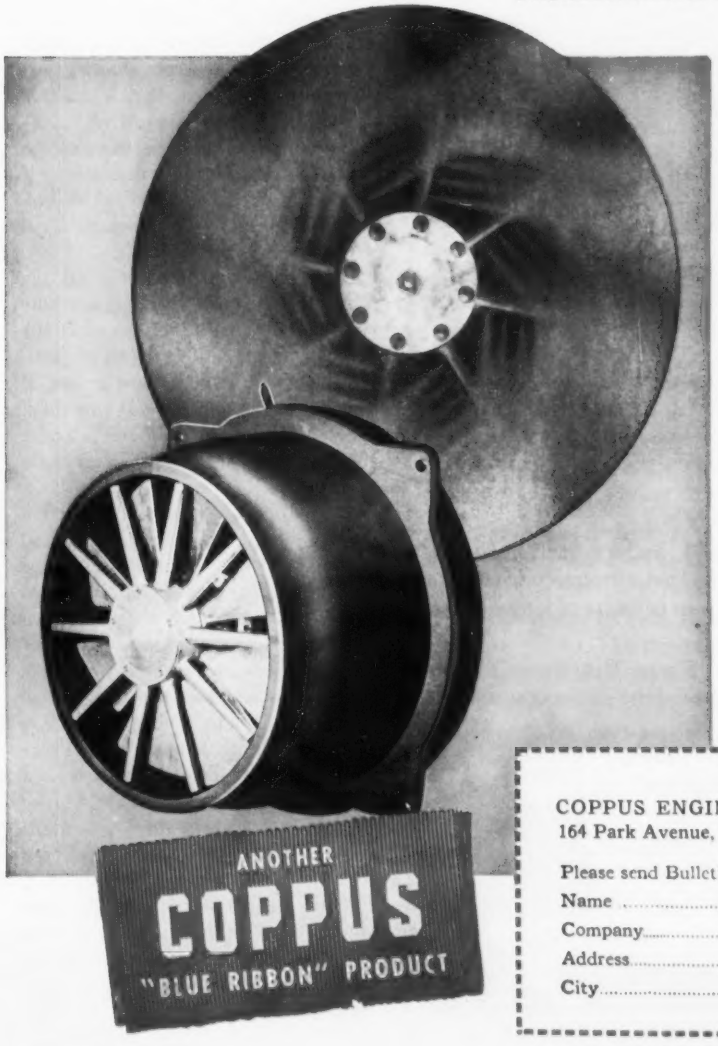
FANMIX can easily be operated with your present furnace and stack, requiring only minor changes in other equipment. Or if you're planning on new boilers, remember that FANMIX relieves the furnace from the burden of mixing, creates its own forced draft and takes smaller pipe sizes. Which means you can plan on reduced combustion space, less stack, no forced draft equipment and lower installation costs all around.



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Style 177AI is dry graphite lubricated to reduce friction to a minimum. Each strand of the closely braided asbestos yarn top jacket is reinforced with Inconel wire. Core consists of long fibre asbestos and flake graphite.

Available in Spools or in Die-Formed Rings. Rings available with either square cross section or with special bevels for concave-convex nest sets.

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JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

Continued from page 194

ing the tubes gave excessive distortion in the positive direction to the point where it seemed to damage the tube sheet. To avoid this, the swaging procedure was changed. Now four tubes are welded in place first, one in each corner of the tube-sheet strip. The tube sheet is set on a machined surface resting on the four tubes. Then remainder of the tubes are set in place and swaged.

The swaging tool has a small included angle (31 deg), putting the major swaging force in the plane of the tube-sheet face. Because of stiffness of the very short (12 in.) tube lengths, there's little bending force in a positive direction. The net effect is a negative distortion for most of the samples.

Rolling also gave distortion in a negative direction in the eight cases using $\frac{7}{8}$-in. tube sheets in Sections II and III. One sample from the four $1\frac{1}{2}$-in.-thick tube sheets showed negative distortion, two slightly positive and one significantly positive.

Examination of these samples indicates that negative distortion is produced with the center of rolling pressure toward the tube-sheet front surface.

This is also the case for all the $\frac{7}{8}$-in. tube sheets. With thicker tube sheets the rollers are set deeper in the tubes producing three cases of positive distortion. In the single case of negative distortion with $1\frac{1}{2}$-in.-thick tube sheets, the depth of roll is about the same used for the $\frac{7}{8}$-in. tube sheet.

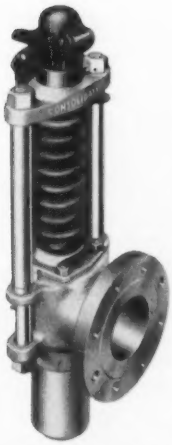
Direction of tube-sheet distortion from welding in both Sections II and III is consistent. All cases show distortion in a positive direction toward the back of the tube sheet. Section III data does indicate a tendency for greater distortion of $1\frac{1}{2}$-in.-thick than $\frac{7}{8}$-in.-thick tube sheets. We tried unsuccessfully to relate distortion data to welding temperature. Probably the thermo-color indication used was too insensitive.

Fig. 4 relates tube-sheet deflections to heat input in watt-seconds used to make a single weld.

Three straight-lined regressions are shown. All are independent of tube and tube-sheet material. One is for $\frac{7}{8}$-in. and the second for $1\frac{1}{2}$-in. tube-sheet thickness. The third is inde-

STOPS VALVE LEAKAGE

at high pressures



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KITTERIDGE

The name behind your deaerator

Welding

Continued from page 196

pendent of both tube-sheet thickness and material.

The correlation of 0.63 is significant for the 1½-in.-thick tube sheet. For ⅞-in.-thick tube sheets the correlation of 0.47 is not very significant. That of 0.38 for all material combinations and thicknesses has even less significance. Since not enough data was obtained and range of variation is small, a valid statistical analysis can't be made.

But a reasonable interpretation of probable meaning is worthwhile. The fact that all regression line slopes are positive indicates that weld distortion is a direct function of energy input. The significant difference between correlations for the ⅞-in.- and 1½-in.-thick tube sheets means that thickness is a definite factor. This is supported by the fact that correlation independent of thickness is less than in the two cases where thickness is held constant. Because all correlations are low, material combinations must also have an effect on tube-sheet distortion, especially since different heat inputs are needed to produce high-quality welds.

Tube-sheet distortion from peening is pretty consistent in Sections II and III. The values are small and varied in direction. Four are positive and four negative. No special significance is attached to this data.

Section III weld strength is included in the table on page 93. High strengths are developed with the two tube materials used with copper-silicon tube sheets. Median values range from a low of 94.5% to a high of 103% for welded-only admiralty tubes. Aluminum-brass tube strength ranges from 97.5% to 104%.

Welded joints using naval-brass tube sheets have a much lower strength than those produced with copper-silicon tube sheets. With admiralty tubes, median values range from 70% to 82.5%. For aluminum-brass tubes the range is from 68% to 74%. The reason for this lower strength isn't apparent. Both copper silicon and naval brass have identical minimum tensile strength, and comparison is with the same tube materials. In addition, weld penetration seems to be more than adequate in the photomicrographs.

(Continued on page 202)

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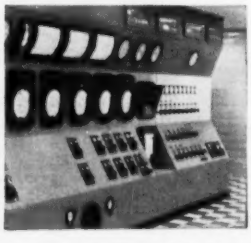

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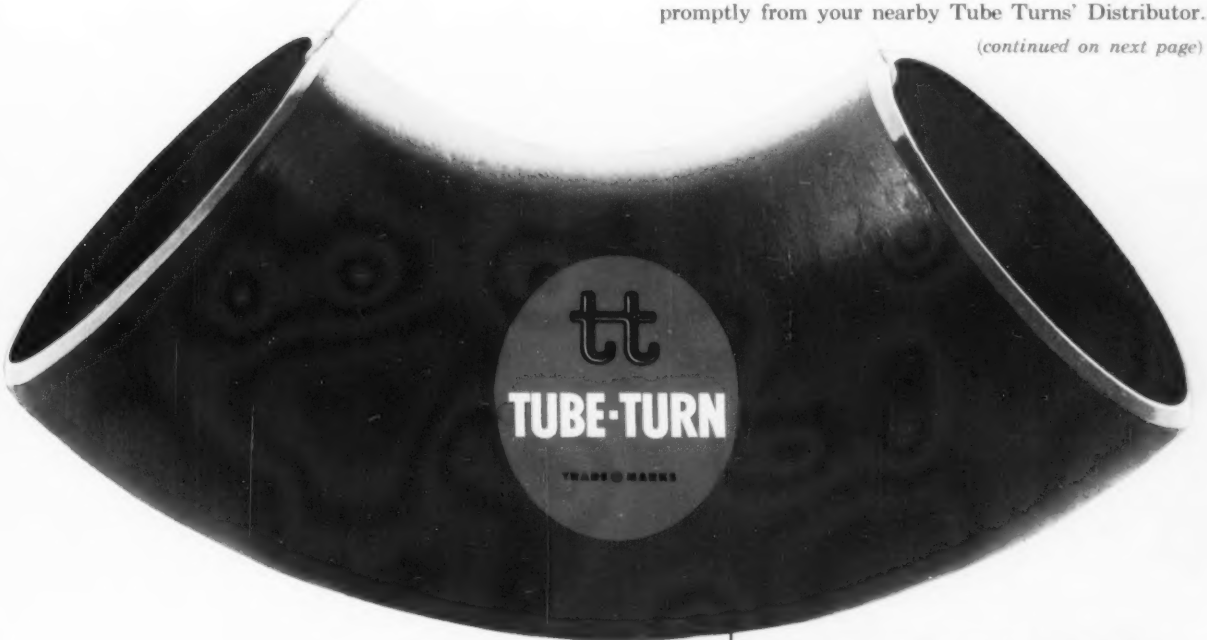
(*continued on next page*)



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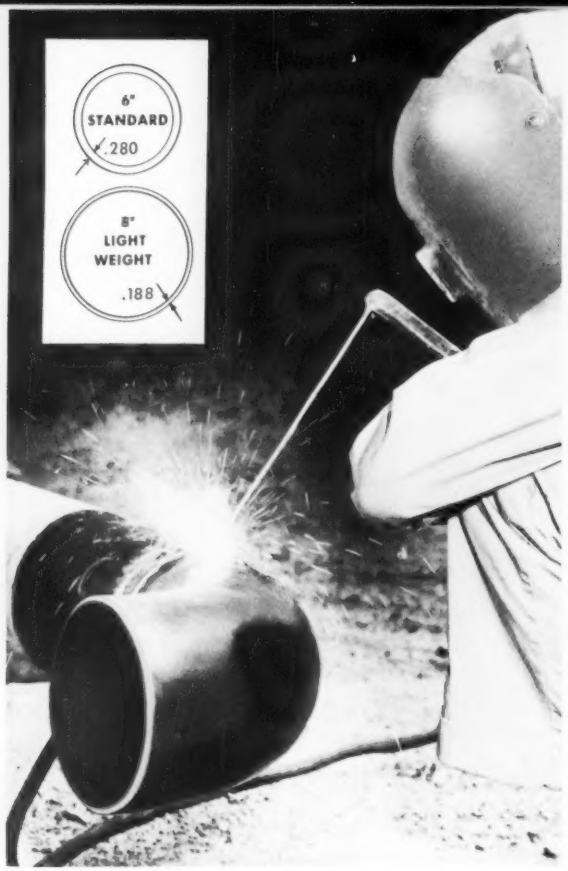

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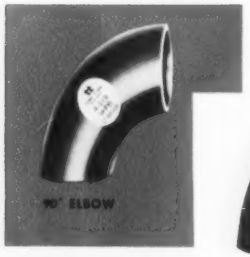
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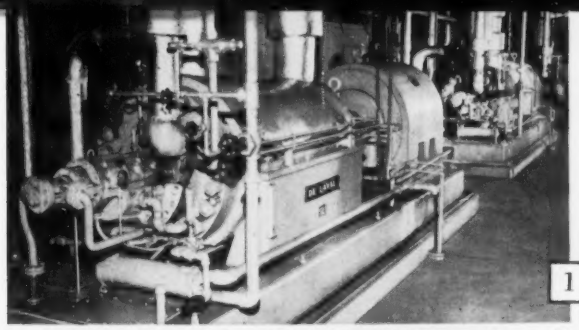

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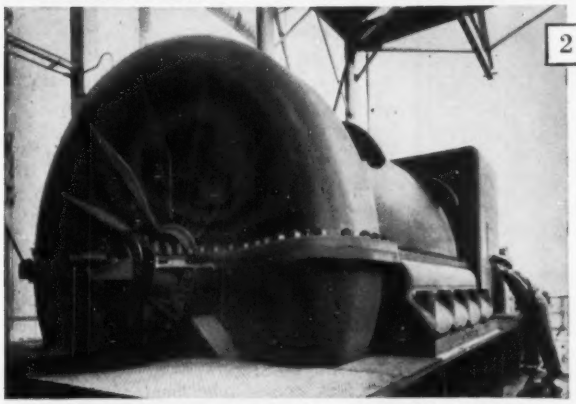

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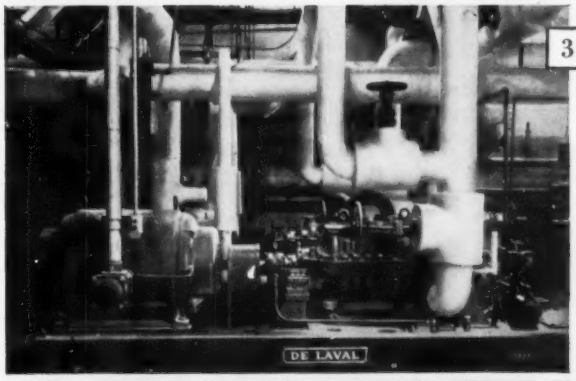

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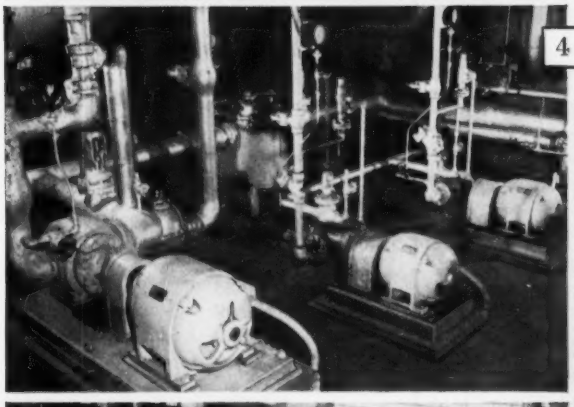

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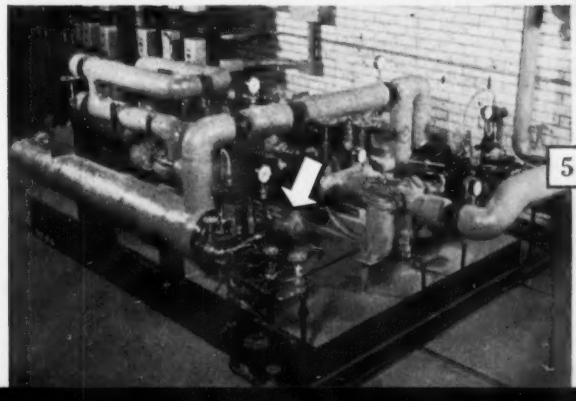

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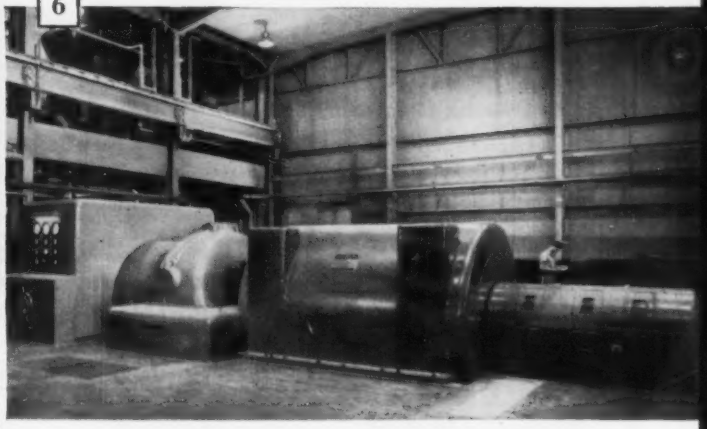

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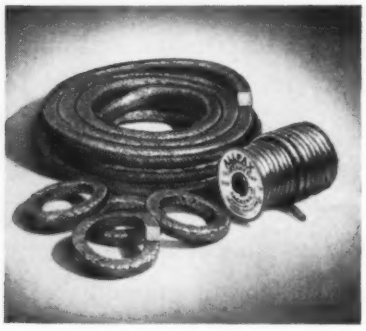

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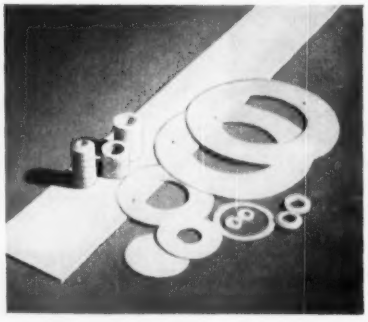

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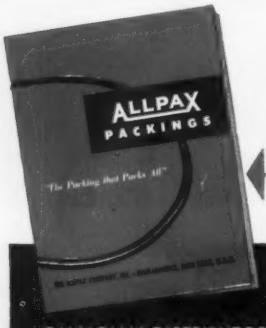

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Welding

Continued from page 198

Loss of weld strength with naval-brass tube sheets is probably due to high zinc-alloy welding problems. This loss of strength is independent of initial mechanical strength of material or degree of weld penetration in the type of joint studied.

It's also interesting to see that rolling added strength three times out of four to the joint with copper-silicon tube sheets. It only increased strength one time out of four with naval-brass tube sheets. There's no apparent explanation for this except that cold-working characteristics of the tube-sheet materials may be different.

Generally the strength for welded-only and welded and rolled joints is good enough to consider welded tubes as stays in tube sheets. There is a high percentage of failures at the median value and generally only a single tube at the extreme low or high value. We can expect a joint strength equivalent to tube strength with admiralty or aluminum-brass tubes combined with copper-silicon tube sheets. Joint strength is about 70% of specified minimum tensile strength with aluminum-brass tubes welded to naval-brass tube sheets.

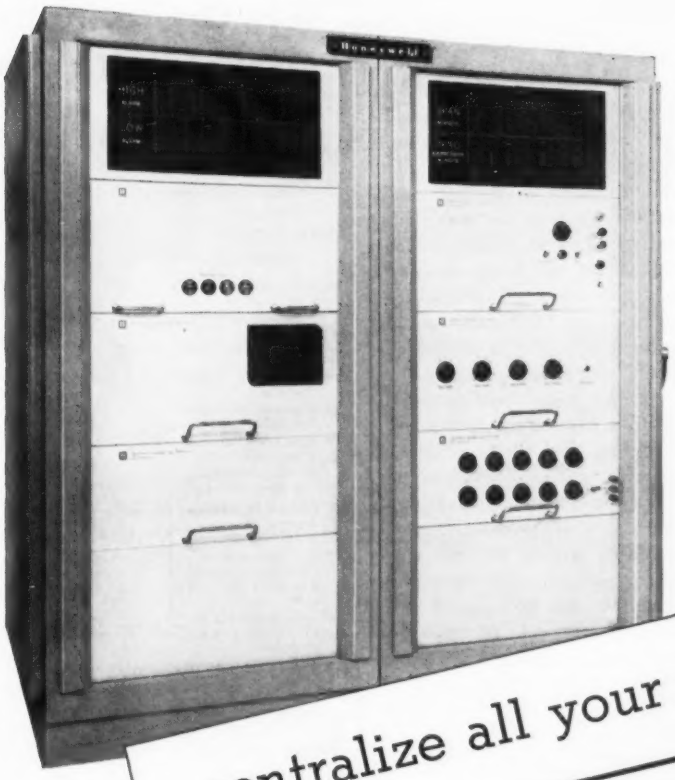
With admiralty tubes and naval-brass tube sheets, the joint strength increases to 80% of tube strength. Loss in strength for this same material combination in Section III H is probably from using argon and helium instead of argon alone in combination with reduced welding current.

Conclusions. Mechanical strength for type of joints used approaches the specified minimum strength of tubes welded for combinations of admiralty - metal and aluminum - brass tubes with copper-silicon tube sheets.

Reduced mechanical strength is the result of welding admiralty - metal tubes to naval-brass tube sheets. Still further reduction is typical of the aluminum-brass tubes and naval-brass tube-sheet combination.

Rolling, in addition to welding, will be more likely to increase strength of stronger joints having copper-silicon tube sheets than add to the strength of weaker joints using naval-brass tube sheets.

Tube-sheet distortion is caused by both mechanical and welding proc-



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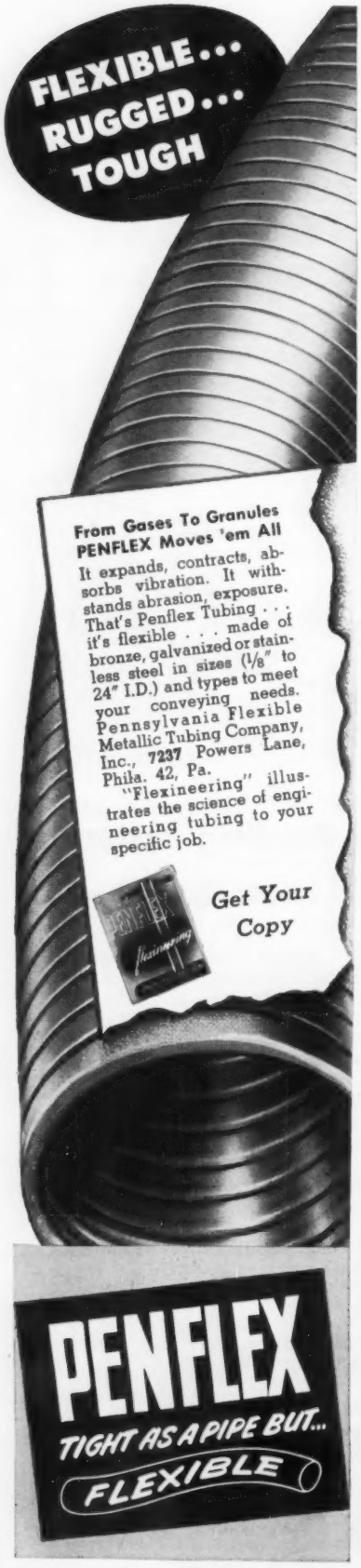
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Welding

Continued from page 202

esses used in tube installation. But consecutive - sequence tube - installation procedure does produce more distortion than skip sequence.

Welding distortion increases with the heat-energy input per weld. Since heat-energy input is related to tube-sheet thickness and material combination, tube sheet distortion is a function of both. Generally welding distortion is opposite in direction to distortion from preceding mechanical steps. In this sense welding can be likened to a heat-straightening process. Welding distortion, while corrective in direction, is small in magnitude for the assemblies used in this test series.

Concluding article in this series will give results of cyclic stress tests on simulated heat exchangers. Photomicrographs of weld sections from the entire test program will help explain some of the results.

Deaerators

Continued from page 90

ternal pressure is suddenly dropped by spraying water into a vacuum. Degree of deaeration by ebullition is influenced mainly by surface tension and gas solubility.

Oxygen remaining in solution after spraying into a steam deaerator or high vacuum is equal to about 0.26 times the product of water-surface tension in centipoises and oxygen solubility in water.

Diffusion. Oxygen residual after spraying is removed by mass transfer (diffusion). One transfer unit is the capacity needed to complete one unit of mass transfer with one unit of driving force. Total required height of packing for a given mass-transfer process equals product of the number of transfer units and height of an individual unit.

For example, removing one cc/liter dissolved gas with a mean driving force of one cc/liter requires one transfer unit. Similarly, removing one ppm of dissolved gas with a driving force of one ppm calls for one transfer unit. Driving force is the difference between actual gas content in solution and its equilibrium concentration.

Height of a transfer unit (HTU) is determined from test. It varies

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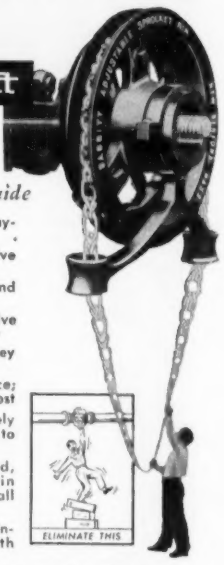

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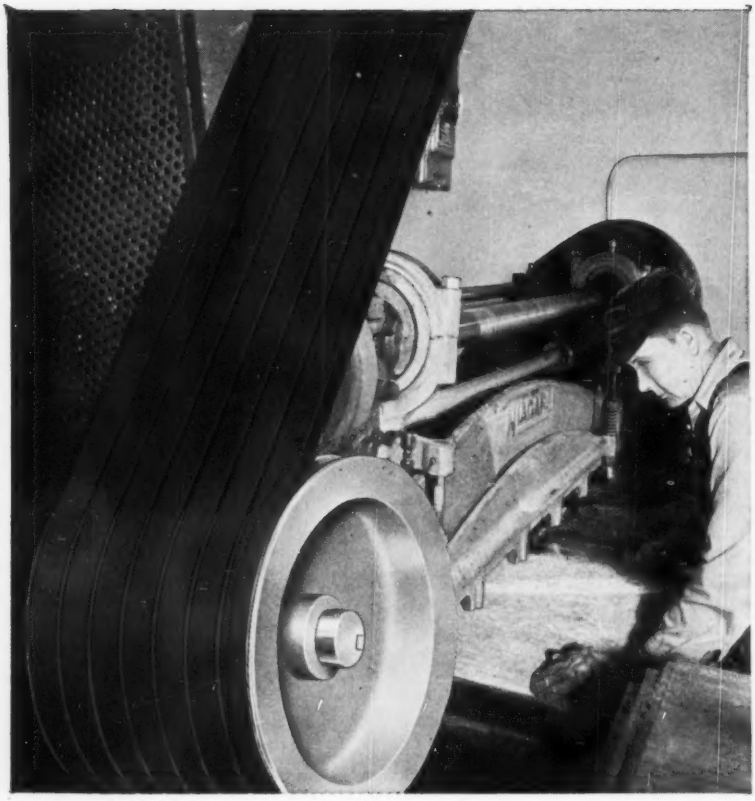

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Make this simple test. Bend a Gates V-Belt with concave sides (Fig. 1) as if it were going around a sheave. Feel how the sides *fill out*... become perfectly straight (Fig. 1-A). Note how this belt makes full contact with the sides of a sheave... grips the sheave evenly, distributing wear uniformly across the sides of the belt. Uniform wear lengthens belt life — keeps costs down.

Now make the same test with a straight-sided belt (Fig. 2). Feel how the sides bulge out, (Fig. 2-A) concentrating wear at the points shown by arrows. Uneven wear shortens belt life; increases belt costs.

Because Gates V-Belts with concave sides are so universally preferred, they are also the *most widely available*. There are Gates distributor stocks in industrial centers throughout the world.

Fig. 1

Fig. 1-A

Fig. 2

Fig. 2-A

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Gates Vulco Rope Drives

Deaerators

Continued from page 204

with specific load rating and other liquid and gas properties. Deaerator evaluation is concerned primarily with removal of oxygen, nitrogen and hydrogen from water. For convenience, HTU values are standardized at 68 F where absolute viscosity of water is one centipoise.

It's difficult to draw a sharp line of demarcation between deaeration by ebullition and deaeration by diffusion. Effect of spraying and preliminary heating is influenced by spraying energy, heating efficiency and physical size of spray compartment.

Deaeration by ebullition stops when sum total of internal water pressure isn't enough to overcome both external pressure and surface tension of the gas bubble nucleus. It's probable that presence of large volumes of other gases, such as carbon dioxide, aid oxygen removal by supplying part of the solution pressure needed to overcome this resistance.

Tray-stack design involves finding (1) number of transfer units needed and (2) height of a transfer unit for specific operating conditions and type of packing or trays.

Oxygen content of water reaching final deaerating section is close to 0.25 cc/liter when handling 100% cold-water makeup. To reduce this to 0.005 cc/liter in the deaerating section, equation (1) shows that about four transfer units are needed.

$$(1)\ \mathrm{TU} = \frac{\text{Change in } O_2 \text{ concentration}}{\text{Log mean driving force}}$$

Deaerator-test results under similar conditions show that about 18 layers of trays are needed. Since this height is needed for four units of exchange capacity, height of a transfer unit must be 4½ tray layers.

Equation (2) gives number of transfer units in a deaerator tray stack under any condition of operation.

$$(2)\qquad \mathrm{TU} = \frac{h(e)}{v^{4/3}}$$

where h = Number of tray layers; e = Tray efficiency per layer at 68F; v = Absolute viscosity, centipoises. First, find number of transfer units from equation (1). Then substitute in equation (2) and solve for h.

Alternately, the height of a transfer unit can be calculated from equation

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Deaerators

Continued from page 206

(3), Total height of trays is then found by multiplying number of transfer units from equation (1) by HTU from equation (3).

$$(3)\ \text{HTU} = \frac{h\,(e)}{v^{4/3}}$$

Use of this arithmetical approach requires access to tray-efficiency values at various load ratings. If these are not readily available, estimate HTU from Fig. 6. Typical tray-efficiency values are plotted in terms of HTU at various liquid rates for deaerator oxygen removal. Similar figures are also given for other packing materials.

Equilibrium concentration. Noncondensable-gas partial pressure and solubility fix amount of gas remaining indefinitely dissolved in water contacting a mixture of water vapor and the gas.

Amount of oxygen held in solution in a process involving a continuous flow of water containing oxygen and a continuous venting of vapors also containing oxygen is directly proportional to the absolute operating pressure and to the amount of oxygen released in process; cc/liter, ppm. etc. It is indirectly proportional to vent rate, expressed as a percent of influent flow rate.

Oxygen-equilibrium valve at any point in the deaerating process is given by equation (4). Plot of typical values is shown in Fig. 7.

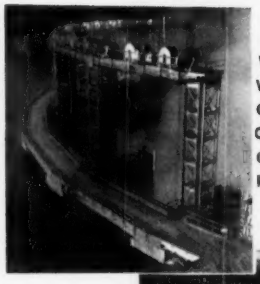
$$(4)\ O_T = \frac{O_2\,(P)c}{V}$$

O_T = Theoretical dissolved oxygen, cc/liter; O_2 = Oxygen released to vent vapors, cc/liter; P = Operating pressure, psia; V = Vent rate, % of water flow; c = Constant of 0.0001.

Varying load. Box on page 89 adjusts for changing load by using a factor of $w^{.263}/W$. The exponent .263 is an average value characteristic of the curves in Fig. 6. Actual value will vary with each manufacturer. In general more intricate packing systems composed of very small packing material have highest rate of change of efficiency with load. More open type packing, composed of larger packing material, will suffer less change in efficiency with load rate variation.

This exponent has a value of .475 for 3/8 in. raschig rings between lim-

Teamed to make Power Progress Possible



WASHINGTON WATER POWER CO. CABINET GORGE PROJECT CLARK FORK RIVER, IDAHO.

MONTANA POWER COMPANY, KERR HYDRO-ELECTRIC PLANT FLATHEAD RIVER, MONTANA.

ONE OF 18 GATE HOISTS FOR LONG SAULT DAM, ST. LAWRENCE POWER PROJECT NEAR MASSENA, N. Y.

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GATE HOISTS

Designed and built in a wide range of capacities from the 18 MURCO Gate Hoists for the St. Lawrence project, each hoist weighing 93,000 lbs. to less than one ton capacity, MURCO Gate Hoists are backed by 75 years experience. From this experience we have accumulated designs and patterns that may fit your requirements. In planning power dam gates, we suggest you write us before your plans for the project as a whole are complete . . . our engineering department recommendations may save expense and important preparation time. Complete information is yours upon request.

D. J. MURRAY MANUFACTURING CO.

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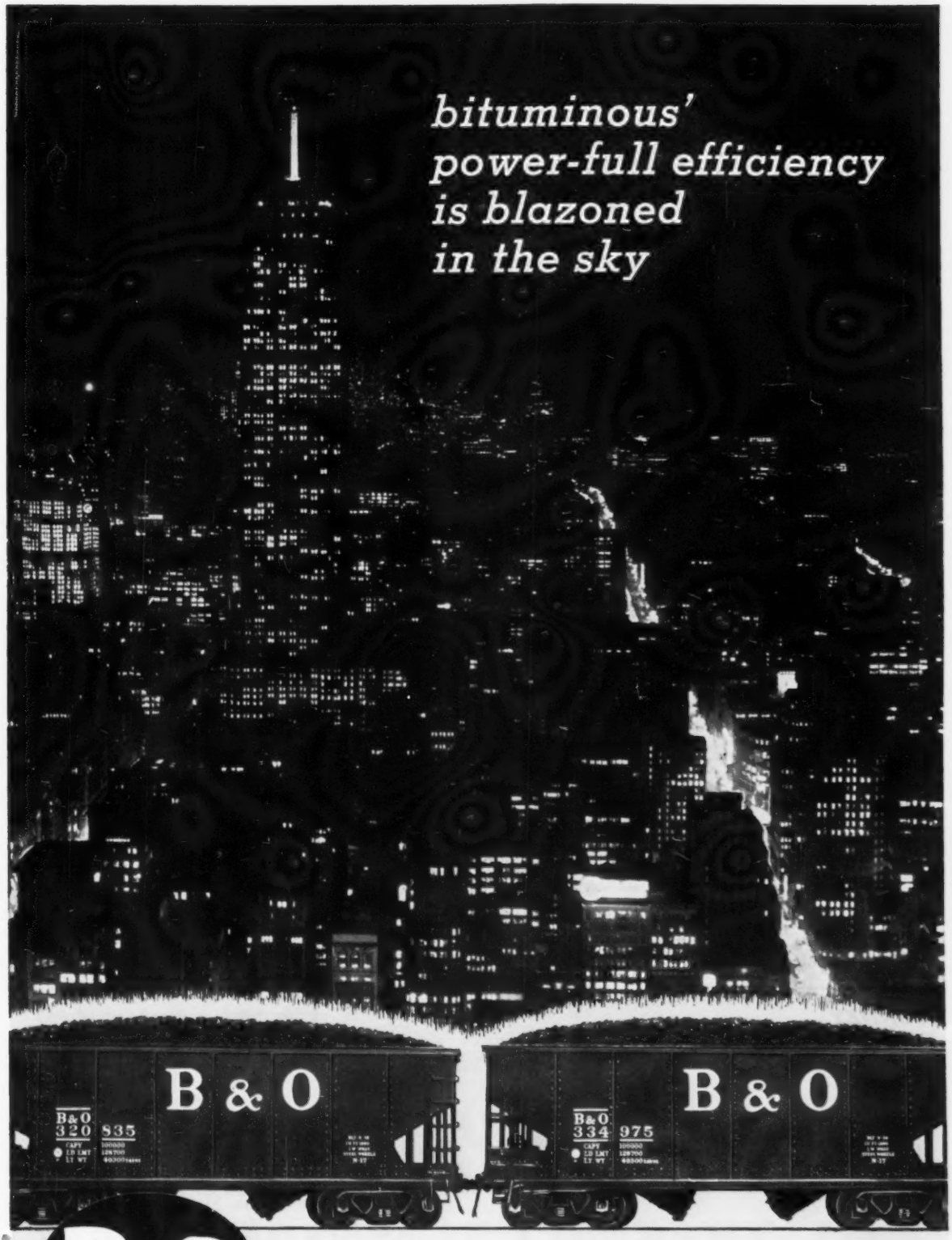

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Note rugged branch construction on this massive oil header fabricated with a length of pipe and five 30 x 12 and two 30 x 30 weldolets.

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BIG MONEY
to be SAVED
by using
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BONNEY
WELDOLETS

Closer manifolding, ease and speed of field fabrication without header distortion, lower purchase and welding costs are just a few of the profit benefits of header fabrication with Bonney Weldolets. Today there is particular need for reducing costs. Bonney Forge can provide this opportunity for cutting costs in your company. Write, phone or wire for details.

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BONNEY FORGE AND TOOL WORKS

DEPT. L ALLENTOWN, PENNSYLVANIA

Deaerators

Continued from page 208

its of 1000 and 14,000 lb/hr/sq ft. For 2 in. raschig rings and load ranges of 500 to 30,000 lb/hr/sq ft, its value is 0.237.

For exploratory analysis, the exponent should be chosen high for overload and low for partial loads. Use 0.3 for investigating performance of an efficient deaerating feedwater heater over load ranges 50% less or greater than design conditions.

Vapor flow rate through deaerator has very little bearing on deaerator performance. Removal of gases of moderate solubility from water is distinctly a process in which liquid film controls. Vapor scrubbing rate has no influence until vapor velocity begins to disturb liquid distribution.

Temperature. HTU varies considerably with liquid temperature and is directly proportional to absolute viscosity of water to the 4/3 power.

These conclusions are based on tests reported at the Mid West Power Conference in 1941. They are generally confirmed by much later work of Sherwood and Pigford. Relative HTU are compared in Fig. 7. Kittredge correction curve passes through unity at 68F where absolute viscosity of water is one centipoise. Sherwood and Pigford data pass through unity at 77F corresponding to their standardization of HTU at 25C.

Spray deaerators. Equation (2) for number of transfer units can be rewritten with kinetic energy of spray deaeration substituted for product of h (e).

$$(5) \qquad TU = \frac{K\,E}{k\,(v^{4/3})}$$

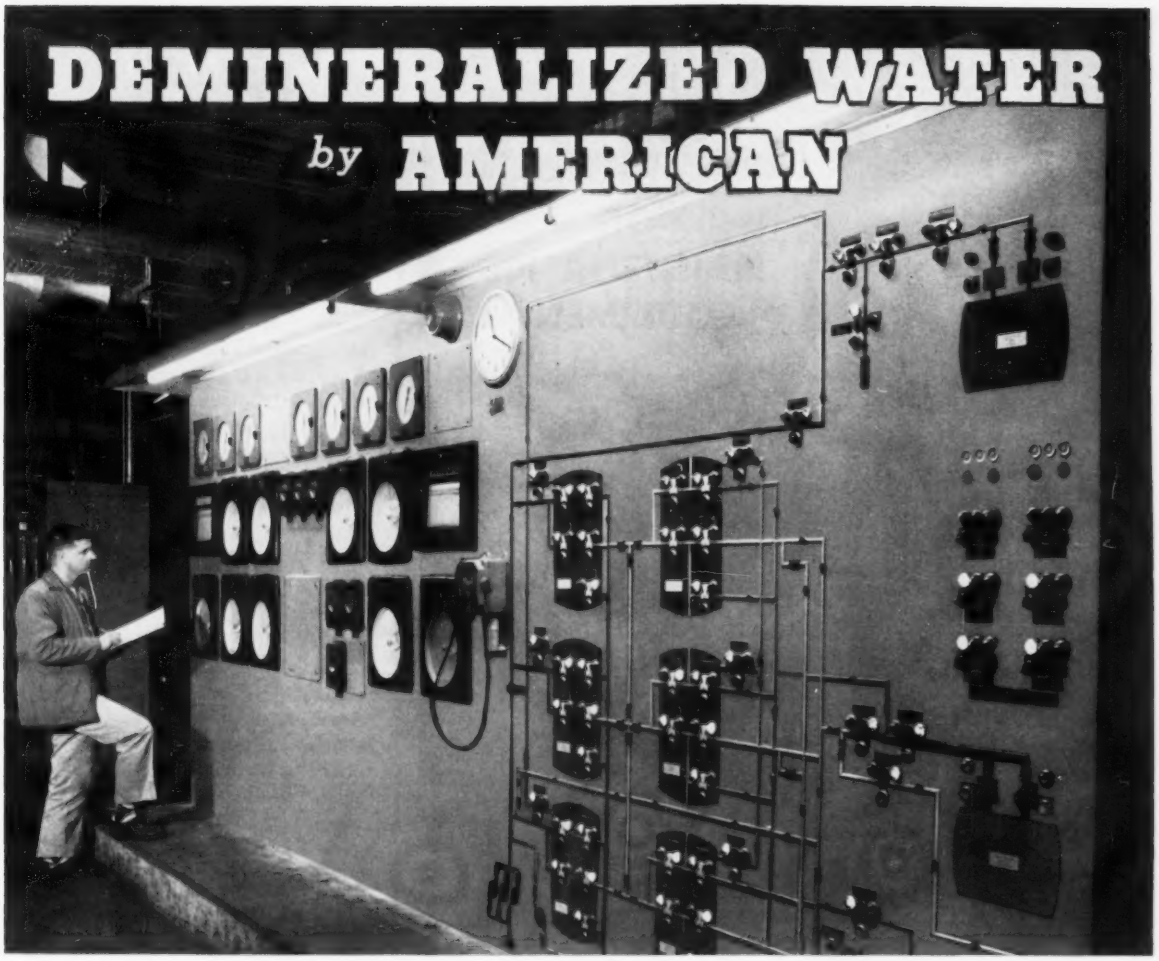
K E = Kinetic energy, ft lb/lb water deaerated; k = constant of 400.

This relationship is reasonably accurate provided that the entire cross-sectional area of deaerating dome is used to disperse the sprayed or atomized water and that load rating of deaerator in lb/hr/sq ft is consistent with experience. A reasonable figure is 10,000 lb/hr/sq ft.

Curve, Fig. 8, shows this relationship for atomizing deaerators using spring or weight-loaded movable steam valves.

Proponents of fixed-orifice spray-type deaerators where finely divided steam bubbles are passed through water have contested validity of the

DEMINERALIZED WATER *by* AMERICAN



The American Water Softener Company is the oldest engineering and manufacturing concern concentrating exclusively on water conditioning equipment. For over half-a-century American has furnished leading industrial users around the world with water treatment installations of all types and capacities. American has a wealth of accumulated experience in designing and constructing softening and filtering plants, deaerators, chemical feeders and other equipment required for the removal of impurities from water supplies. For the answer to your own problem, consult American.

AT UNION BAG-CAMP PAPER CORP. SAVANNAH, GA. • The demineralizer unit, designed and built by American Water Softener Company, in the water treatment section of Union Bag-Camp Paper Corp.'s new power plant, utilizes a colorful graphic flow diagram as part of the control panel (as shown in photo above). Tanks are depicted in black silhouette, as are pumps, valves, line ends and mixing chambers. Valve symbols are silver or white, while pipe lines are color coded for easy interpretation. Ten colors are employed with color code panel at lower right.

SINCE 1902

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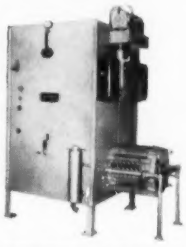
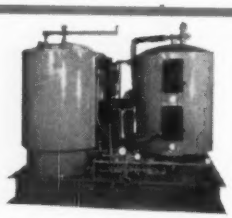
OIL RECLAIMER

For continuous oil purification in range of 2-100 gph. Removes all solids, acids and volatile contaminants.



PURIFIER-RE-REFINER

For all purification in batches of from 6 to 100 gallons. Removes all solids, acids and volatile contaminants.



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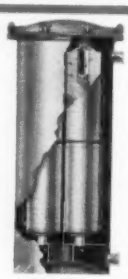
Combines filtration for removal of solids and sludge with vacuum vaporization for removal of solids, acids, water, solvents, fuel dilution. Furnished in standard or custom built models to 600 gph.



FILTER

Furnished in capacities from 0.1 to 750 gpm. Various cartridges available for mineral and inhibited detergent oils.

Whenever oil is used it becomes contaminated and must be discarded or conditioned for further use. There is a HILCO to do this job for you. HILCO offers a wide range of oil purification units to meet every oil conditioning problem . . . stationary or portable. You can recover large quantities of oil at low cost. HILCO units are available for continuous or batch operation. And HILCO purification means complete oil purification.

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- Diesel Engines
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- Tractors
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- Gas Engines
- Automobiles
- Buses
- Heat Treating Systems
- Locomotives
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Deaerators

Continued from page 210

energy principle for this deaerator. While we certainly can't say that every design is of equal efficiency, use of the energy concept on reboiler designs is amazingly accurate.

These deaerators usually make initial steam release about 18 in. below maximum water level in the deaerating throat. About two cubic feet of steam per pound of effluent is used. Buoyancy of a cubic foot of steam in water is about 60 lbs. Energy dissipated by movement of steam bubbles through water for a distance of $1\frac{1}{2}$ ft is product of buoyancy and distance. It amounts to $2x60x1\frac{1}{2}$, or 180-f-lb.

Comment

Continued from page 142

stage wash system. Agreed, the changeover point might be difficult to define accurately. But there must be some guiding principles or rules which could be passed along to operators for their guidance.

Since it's becoming more necessary for diesel plants to look to the use of lower cost residual fuels for economical operation, more information on solving the problems will be welcome. This article by D M Landis and E G Bahret should only be considered a start in this important field.

LEE SCHNEITTER
Mechanical Engineer
Ebasco Services, Inc, N. Y.

EDITOR'S NOTE: *Reader Schneitter's letter is typical of a flock of requests we've gotten for more info on overall costs of the setup described in the Landis and Bahret article. Since the Subic Bay installation is relatively new, a lot of cost figures won't be available right away. However,* POWER *will have something to say in the near future about the residual fuel-oil picture—not only regarding its use in diesel engines, but also as a boiler fuel.*

Too, a lot of you spotted the error in the caption for the photo, top left, p 89. Instead of the vest-pocket models indicated, generators are rated at 4800 kw. (Aside to Reader Fisher, New Haven, Conn: Engines have $21\frac{1}{2}$-in. dia cylinders, 31-in. stroke, and speed is 240 rpm.)

News and Notes on...

Good Packing Practice

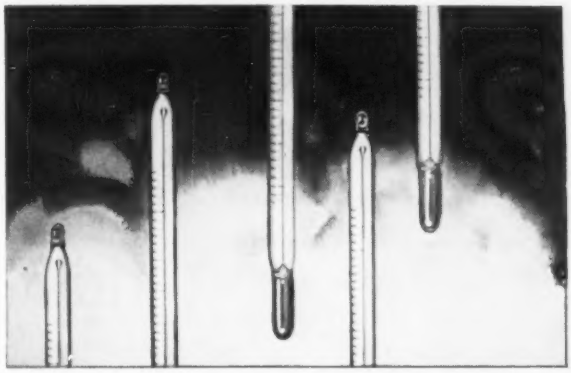
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: High Operating Temperatures

Question:

What sealing materials are currently available that will match conditions brought about by higher and higher operating temperatures?



Condition 1

FOR LASTING VALVE SEALS AGAINST SUPERHEATED STEAM AND DRY GASES

Designed to meet today's demand for a packing that will maintain a tight seal against steam and dry gases on valves working at line temperatures up to 1200F, J-M High-Temperature Valve Stem Packing, Style 397, offers the three-way protection of a heat-resistant plastic core, asbestos yarn, and Inconel wire reinforcement. For lasting protection of valve stems during storage, this efficient packing is now available with J-M No. 9 corrosion inhibitor.

Condition 2

FOR UTILITY SEALING IN GENERAL APPLICATIONS REQUIRING HEAT AND FLAME RESISTANCE

Wherever your operation calls for a utility gasketing material that withstands both heat and flame, specify J-M Asbestos Rope, Style 4200. Made of 99% pure asbestos, this material can take temperatures far in excess of other grades of rope. You'll find it a handy, reliable gasket for sealing joints between furnace doors and brickwork, boiler expansion joints, blast furnace connections, ingot moulds, and countless other uses. Ask for information about J-M Style 4200 Asbestos Rope.

Condition 3

FOR FLANGES WORKING AT TEMPERATURES TO 1600F AND HIGHER

Elevated temperatures are efficiently sealed using J-M Goetze V-Tite Gaskets. Used in flanges grooved for ring joint gaskets. Materials are available for service ranging upwards of 1600F. Controlled hardening assures correct flow of material at low bolt stress. Temperature range —320F to +1600F and higher.

Condition 4

FOR PACKING PROBLEMS IN ANY TEMPERATURE RANGE

Your Johns-Manville field representative is a trained specialist in packing problems of all types. He's located near you, to help out whenever you need specialized packing information. For information on new packings and gaskets—for engineering and design advice—for tips on more efficient, more economical packing techniques—your Johns-Manville representative is a good man to know.

For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

VERSATILITY sells CADWELD electrical connections

CADWELD electrical connections have 5 basic outstanding features:

1. Permanent — cannot loosen or corrode.
2. 100% current carrying capacity.
3. Compact — easily installed.
4. Light weight equipment.
5. Portable equipment — requires no outside source of power or heat.

BESIDES THESE FEATURES IS A SIXTH MAJOR POINT THAT OUTSELLS ALL FIVE — *VERSATILITY*

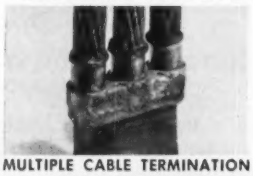
Once any customer has made a CADWELD electrical connection he knows the process. From that point, the only change is in the individual mold design. Todays catalog, lists over 58 basic types of connections — one year ago, there were only 32. The specials have become standards, because our customers approve the high quality of CADWELD and request it on new applications every day.

Send in your special electrical connection, it will be a standard CADWELD connection tomorrow.

TUBULAR BUS TERMINATION

MULTIPLE TAP CABLE TEE

CRANE RAIL POWER FEEDER



MULTIPLE CABLE TERMINATION

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Reports from the field

Begins on page 152

precipitators on a "flange to flange" basis. The manufacturer bids on the precipitator unit only, and has no control over flue design. Short-range economic and space considerations often result in badly designed flues, with short ducts and sharp right-angle turns lowering overall efficiency.

Gas-flow studies with plastic models can indicate ways to reduce or eliminate unbalanced gas flow, turbulence, eddies and vortexes in flues, increasing efficiency by 85%, according to Dr Harry J White of Research-Cottrell, Inc. Research-Cottrell test engineers develop *Plexiglas* models scaled to 1/16 the size of the prospective installation; use them to study the exact conditions under which the individual precipitator will operate. Flow patterns through various flue arrangements are tested with threads, ribbons, ground cork and dust, in addition to smoke, to determine most advantageous flue design.

Model studies have already shown that it's possible to eliminate drop-out hoppers in flues leading to precipitators, saving on initial investment and maintenance. Improved design has reduced the pressure drop as much as 1-in. wg for estimated savings of $40,000 to $80,000. Reduction of turbulence makes cleaning units more efficient, so that smaller precipitators can now do bigger jobs.

Calendar of Events

April 14-15 — American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference. Penn-Sheraton Hotel, Pittsburgh, Pa. Details from ASME, 29 W 39th St, New York 18, N. Y.

April 14-17 — American Society of Mechanical Engineers, Design Engineering Conference. International Amphitheatre, Chicago, Ill. Details: ASME, 29 W 39th St, New York 18, N. Y.

April 24-25 — American Society of Mechanical Engineers, Management Conference. Hotel Statler, New York. Details from ASME, 29 W 39th St, New York 18, N. Y.

(*Continued on page* 216)

SOLID WHEEL

spells non-stop turbine performance

It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

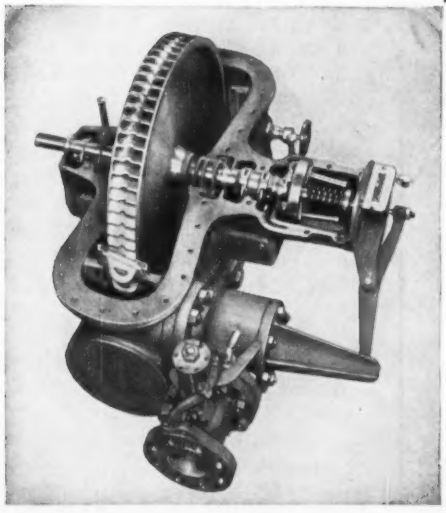
The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.

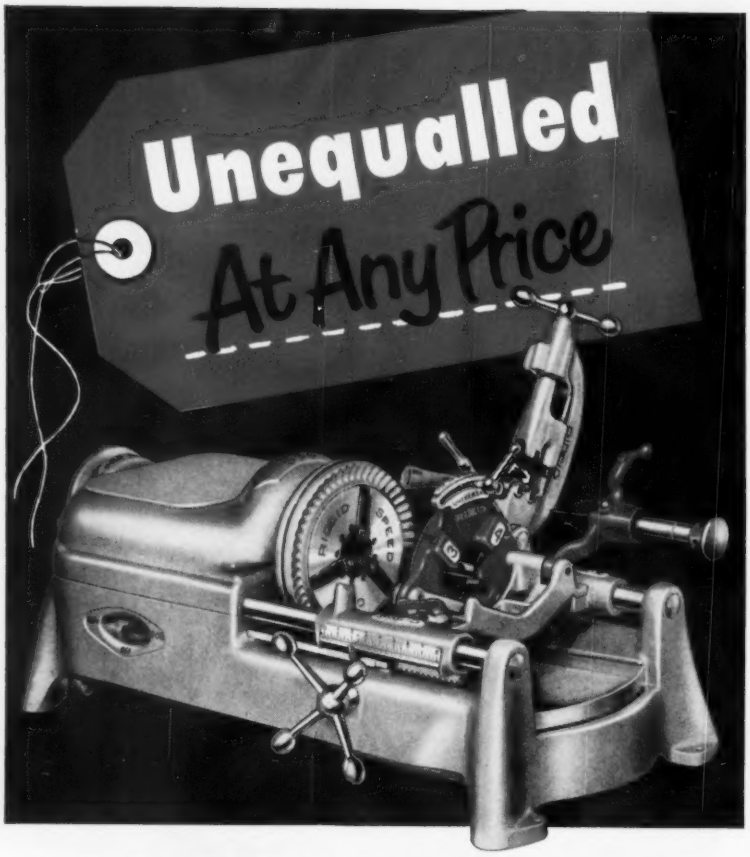
Terry Square, Hartford 1, Conn.



Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY



RIDGID No. 535

Pipe & Bolt Threading Machine
Complete with 1 Universal Die Head
and 2 Sets of Dies, ½" to 2"...

Built like a machine tool, designed to thread, cut and ream with speed and ease no other machine offers you. Compare its slip-proof Speed Chuck, front chucking, instant size-change right in carriage, and many other RIDGID features. It pays you to see and try this most-for-your-money 535 at your Supply House before you decide.

The Ridge Tool Company, Elyria, Ohio, U. S. A.

Reports from the field

Begins on page 152

May 1-8 — American Society of Tool Engineers, Tool Show and 26th Annual Convention. Philadelphia Convention Center, Philadelphia, Pa. Details from ASTE, 10700 Puritan Ave, Detroit 38, Mich.

May 2—Ohio State University College of Engineering, Fifth Annual Conference for Engineers and Architects. Ohio Union Hotel. Details from Associate Dean Harold A Bolz, Ohio State U.

May 4-7—Air-Conditioning and Refrigeration Institute, Board and Annual Meeting. The Homestead, Hot Springs, Va.

May 7-11, 1958—Western Air Conditioning Industries Assn, Conference and Exhibit. Shrine Exposition Hall, Los Angeles. Details: F J Tabery, 3443 S Hill St, Los Angeles 7, Calif.

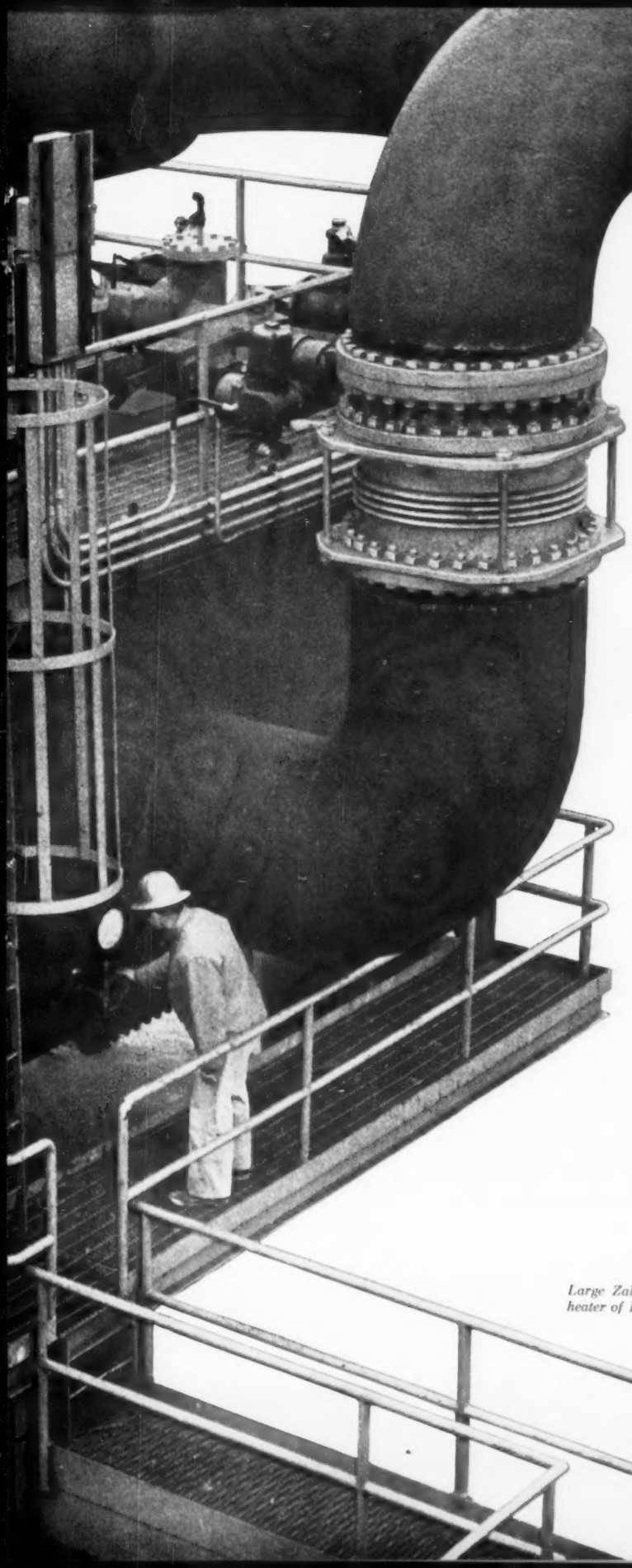
May 8 — American Society of Mechanical Engineers, Mid-Hudson Section, Steam Power Plant Design Conference. Poughkeepsie, N. Y. Chairman is William B Legier. Details from Edmund McCarthy, Pocahontas Fuel Co, Inc, 207 Derby St, Salem, Mass.

May 12-16 — American Society for Metals, Southwestern Metal Congress and Exposition. Automobile Bldg, State Fair Park, Dallas, Texas. Details from ASM, 7301 Euclid Ave, Cleveland 3, Ohio.

May 14-17—Society for Experimental Stress Analysis, Spring Meeting. Hotel Manger, Cleveland, Ohio. Details from Dr W M Murray, Box 168, Cambridge 39, Mass.

May 19-23 — National Safety Council, Safety Management Techniques training course. Details from Director of Industrial Training, NSC, 425 N Michigan Ave, Chicago 11, Ill.

May 26-27—Stanford Research Institute, Western Area Development Conference. Vancouver, B.C. Details from C L Hamman, Economics Research Div, Stanford Research Institute, Menlo Park, Calif.



Get positive piping protection with

ZALLEA NON-EQUALIZING EXPANSION JOINTS . . .

Zallea Non-Equalizing Corrugated Expansion Joints offer a degree of protection that can't be equalled for absorbing movement of piping due to temperature changes. They protect interconnected equipment by absorbing movements in otherwise rigid piping systems. They are used in low pressure and vacuum lines . . . between stills, tanks, columns, condensers, pumps and similar equipment.

Standard Sizes: 3″ to 72″ dia.; Special sizes to 50 ft. dia. Pressures: Vacuum to 50 psig. Temperatures: to 1600°F.

Special Applications. With the addition of proper components, Zallea Non-Equalizing Expansion Joints can be used as:

Universal Expansion Joints to absorb movement in any direction . . . axially, laterally, angularly, or any combination of these.

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Hinged and Gimbal Expansion Joints for piping systems that cannot be anchored in the conventional manner.

Get the complete story of Zallea Expansion Joints in our new 72-page manual. They are available for any pressure condition to 3600 psig. Write, on your company letterhead, for your copy of Catalog 56.

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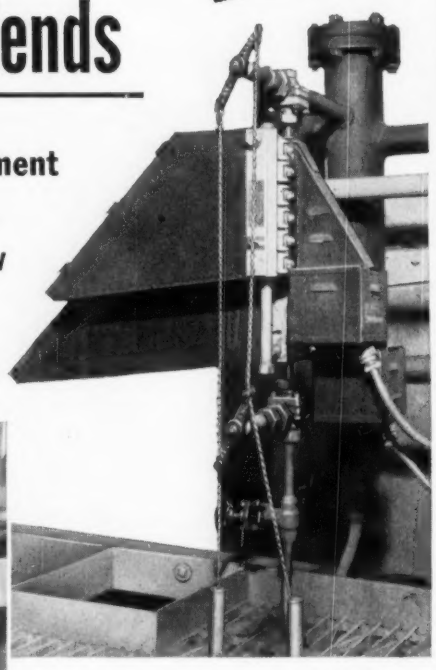
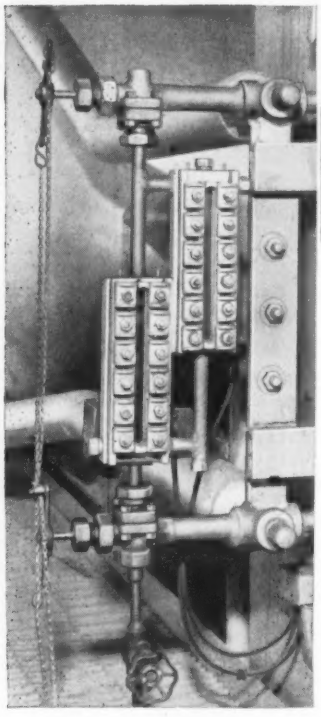
World's largest manufacturers of expansion joints

Large Zallea Non-Equalizing Expansion Joint installed on deaerating heater of Ford Motor Company's River Rouge plant.

Boiler Water Level Security Pays Dividends

. . . Reliance Equipment insures safe, sure supervision for low or high pressure plants





"Two water gages on all boilers operating at over 400 psi" says the code. Here's an example, in the municipal light and power plant of Coffeyville, Kans., illustrating modern Reliance 900 psi equipment.

Water column includes whistle alarm; is equipped with flat glass gage insert, periscope hoods to reflect image through cat-walk opening to a floor-stand mirror below; and mercury lamp illuminator for sharp, brilliant projection. The second gage, also of double-window flat glass construction, is custom-made with tie-bar, for direct-to-drum installation.

Reliance builds for all pressures — brings you a complete line of boiler safety devices. The long record of efficient, dependable service — the extra margin of safety built into all Reliance Equipment — assures long life and low maintenance. Check with your consultants or ask for nearest Reliance Representative address.

The Reliance Gauge Column Co.
5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns . . . . in 1884

Reliance®

BOILER SAFETY DEVICES

Technical briefs

Begins on page 154

strated that a properly designed outdoor station is satisfactory for the Pennsylvania climate.

Many design features incorporated in the station to reduce construction and operation costs are discussed in the paper. The author believes these features can be used to advantage in other stations designed for other operating and climatic conditions.

Paper discusses structural features, water treatment, high-pressure steam pipes, mobile crane, yard surface, transil oil-handling facility, etc. *ASME paper, No. 57-PWR-2*

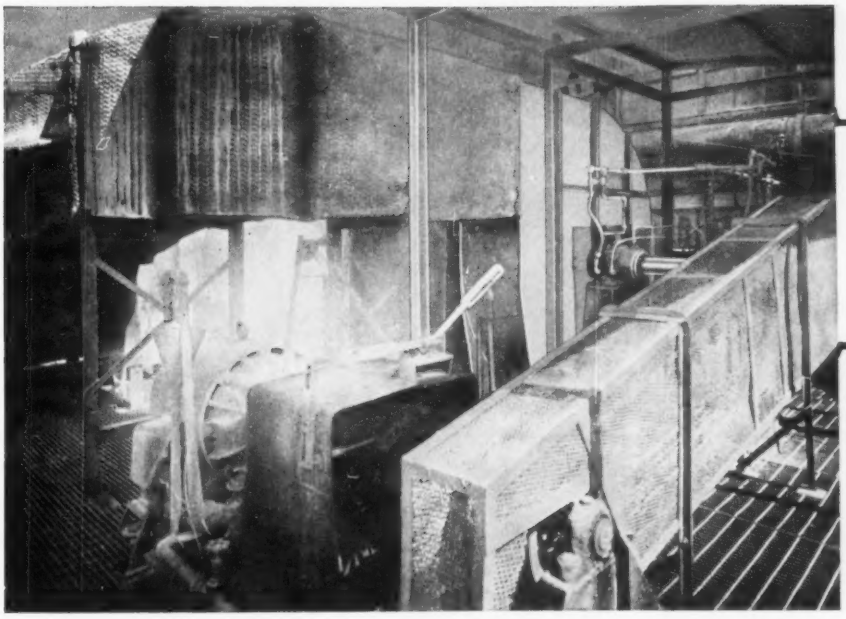
Lubrication

A study of the effect of wear articles and adhesive wear at high contact pressure. *By B E Sciulli and G M Robinson, Franklin Institute*

The study attempted to determine the wear rate and friction characteristics of certain combinations of stellites and stainless steels when rubbed together at unit pressures up to 300,000 psi in an environment of demineralized water at room temperature. Wear rate and friction data were collected both in the presence and absence of wear particles. The effect of sliding-surface geometry in trapping wear particles was also studied.

The results suggest that an exponential relationship exists between wear rate and stress for the materials of the test. However, when these exponential curves are plotted on Cartesian coordinates they can usually be approximated by two straight lines (and a connecting knee). Slope of the line at the higher stresses is many times greater than the slope at the lower stresses. Wear rate appears to increase sharply at some nominal contact stress; this has led to use of the term "Apparent Critical Stress," abbreviated ACS. The value of ACS was not a true constant, being influenced somewhat by sliding velocity and geometry of test specimen.

Data shows that the wear rate varies from 0.01 to over 50 microinches per inch of travel depending on contact pressures, material combinations and speed of sliding. Friction coefficients vary from 0.25 to 0.80, again depending on material combination, speed of sliding and



One of several Clarage Type XL Fans used in this application. Fan equipped with stainless steel wheel and V-belt driven from a hydraulic coupling.

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Exhausting 800° F gases from rotary calciners through scrubber units and electrical precipitators to the atmosphere.

That's the demanding task this large chemical manufacturer gave Clarage Type XL Fans.

What kind of a job evaluation does Clarage receive? Several repeat orders furnish the answer. In fact, three additional Clarage Fans will soon be installed in a major expansion at this plant.

You, too, will find it pays dividends to choose the fan name of quality — Clarage. Call us in for capable assistance on your next requirements in the air handling and conditioning field. It's characteristic of Clarage equipment to prove out successfully no matter how exacting the application. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

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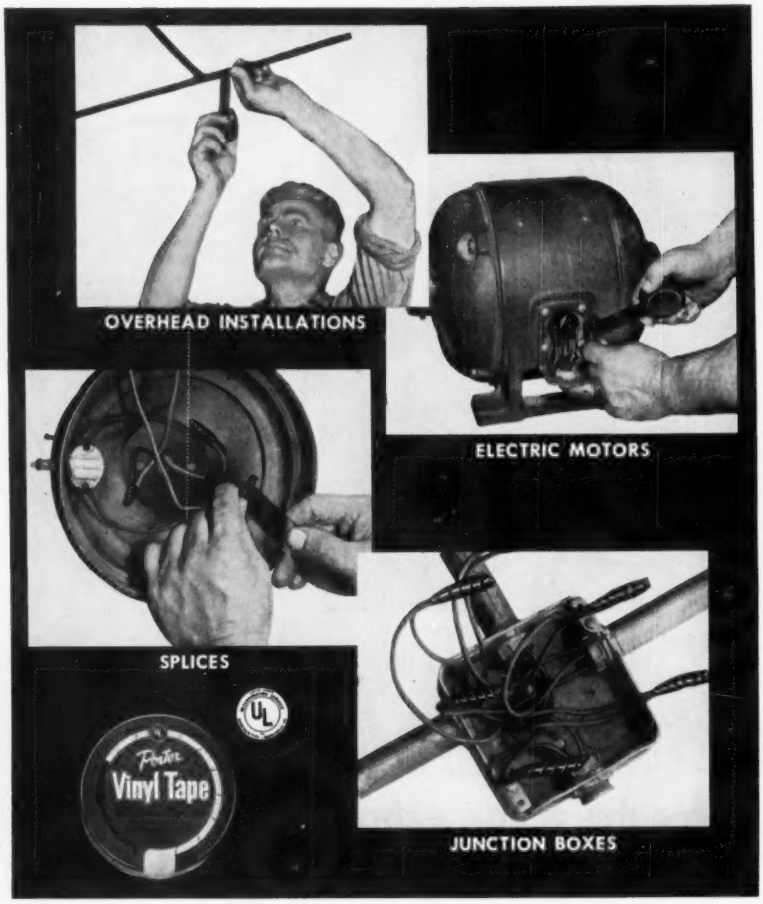

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Technical briefs

Begins on page 154

load. From a limited number of tests where particles formed by rubbing were purposely trapped between the contact surfaces, it appears that the wear rate is definitely increased by accumulation of wear particles. *ASLE paper, No. 57LC-2*

Wear of cobalt base and stainless materials in high-purity water. *By N B Dewees, Westinghouse Atomic Power Division*

Results of wear and friction tests in clean water at room temperature and at 500 F are presented. The differences in result with 0.08-in. diameter and line contact riders and with much larger riders are shown. The contact stress range is from 10 to 9000 psi for large contact areas and from 3000 to over 100,000 psi for small contact areas.

The majority of the testing was at a linear velocity of about 2 in. per sec but some effects of lower velocity are indicated. The concept of wear per unit load and per unit distance traveled for a unit wear area is used for converting sliding wear data from various test machines to a common basis for comparison. The same concept can be used for calculating from wear data the expected wear in a new design. The range and trend of friction values encountered in some of the tests is presented. *ASLE paper, No. 57LC-1*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Lubrication Engineers, identified by initials ASLE. Information as to availability from ASLE, 84 E Randolph St, Chicago, Ill.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits.

CAUSE: lack of chemical stability in feed water.

REMEDY: properly balanced water treatment.

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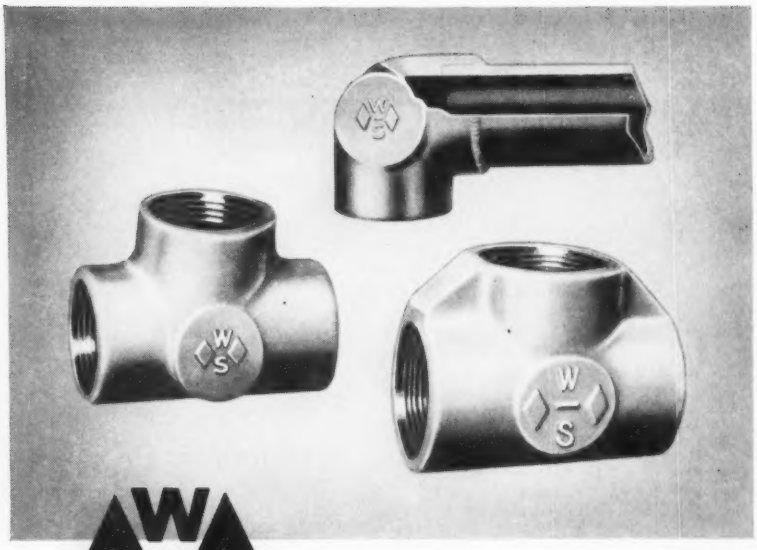

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Free literature

Begins on page 165

MAINTENANCE EQUIPMENT

11 **Housings,** weatherproof and explosionproof models, are discussed in 16-p bulletin *B 158*. Contains selection data, specs, photos. The Adalet Manufacturing Co, 14300 Lorain Ave, Cleveland 11, Ohio.

12 **Black granite** surface plate is described in illustrated bulletin. Manufacturer will also include souvenir desk weight. Collins Microflat Co, 3249 W El Segundo Blvd, Hawthorne, Calif.

13 **Trap maintenance** with temperature-indicating crayons is discussed in 2-p reprint. Includes case histories to make technique clear. Tempil Corporation, 132 W 22nd St, New York 11, N. Y.

14 **Cleaning machines,** light and heavy for all applications, are subject of 49-p illustrated booklet. The Kent Co, Inc, Rome, N. Y.

MATERIALS HANDLING

15 **Rider-walkie** trucks are subject of 14-p booklet. Includes sectionalized views, cutaway pages. Yale Materials Handling Div, Yale & Towne Mfg Co, 11,000 Roosevelt Blvd, Philadelphia 15, Pa.

16 **Vibratory** bulk materials-handling equipment including vibrators, packers and jolters are listed in 60-p illustrated catalog *5712*. Includes descriptions, specs. Syntron Co, 492 Lexington Ave, Homer City, Pa.

17 **Overhead,** in-floor conveyors are described in 8-p brochure. Includes photos, lists of features. Conveyor Systems, Inc, 6451 Main St, Morton Grove, Ill.

18 **Pneumatic conveyor systems for** bulk materials are listed in 4-p bulletin *P58G*. Illustrated with detailed diagrams. National Conveyors Co, Inc, 25 Industrial Ave, Fairview, Bergen County, N. J.

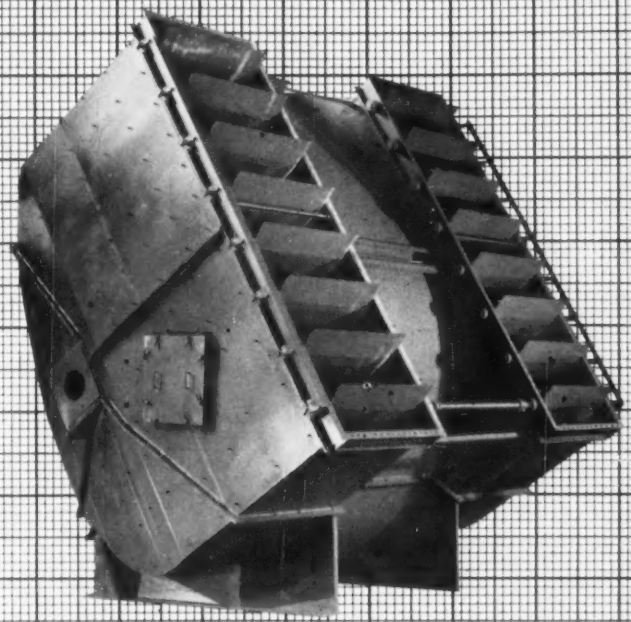
19 **Electric lift trucks** are described in 4-p brochures *1005W*, *1006W*, *1007W*. Drawings, specs included, components and features. Automatic Transportation Co. 149 W 87th St, Chicago, Ill.

MECHANICAL TRANSMISSION

20 **Shaft-mounted drives** are subject of 32-p bulletin *7100*. Includes selection tables, installation pictures, diagrams. The Falk Corp, Dept 255, 3001 W Canal St, Milwaukee 1, Wis.

21 **Pulley lagging,** its uses and methods of application, are discussed in

AMERICAN BLOWER SIROCCO FANS



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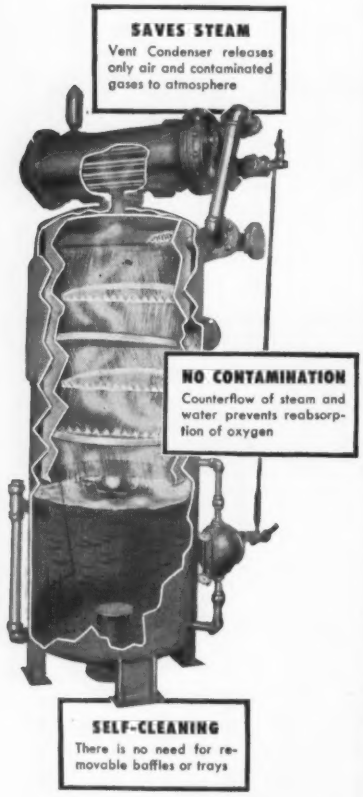
Stop Corrosion

in boilers, steam and return lines . . .

with this Stickle deaerating feed water heater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Begins on page 165

4-p folder. Condersite Engineering Corp, 2015 Chancellor St, Philadelphia 3, Pa.

22 **Piston-ring replacement** is discussed in 8-p brochure. Includes procedures for checking pistons and cylinders, installation info. Piston Ring & Seal Dept, Metal Products Div, Koppers Co, Inc, Baltimore, Md.

23 **Worm gears,** double-enveloping type, are described in 8-p bulletin *CD-575*. Assembly methods are illustrated with cutaway photos. Cone-Drive Gears Div, Michigan Tool Co, 7171 E McNichols Rd, Detroit 12, Mich.

METERS AND INSTRUMENTS

24 **Automatic control** package for hot-, chilled-water unit ventilators is described in 3-p data sheet. Barber Colman Co, Automatic Controls Div, Rockford, Ill.

25 **Actuators,** pneumatic-power type, are subject of 12-p bulletin *B-50-3*. Describes operation, includes application data, photos, specs. Conoflow Corp, 2100 Arch St, Philadelphia, Pa.

26 **Pyrometer** supplies are listed in 54-p catalog *G100-8*. Includes photos, specs. Minneapolis-Honeywell Regulator Co, Industrial Div, Wayne & Windrim Aves, Philadelphia 44, Pa.

★ **Electrical controls** are listed in 64-p catalog *18*. Four indexed sections cover automatic transfer switches, contactors, special controls and timing devices. ★Request direct on company letterhead. Zenith Electric Co, Dept PRN, 152 W Walton St, Chicago 10, Ill.

27 **Flow meters,** differential-pressure type, are subject of 22-p illustrated bulletin *F1607*. Includes installation data. The Bristol Co, Waterbury 20, Conn.

28 **Indicating controllers** for pressure-temperature control are described in 16-p catalog *510*. Tables of ranges, element characteristics, bulb lengths included. United States Gauge Div of American Machine & Metals, Inc, Sellersville, Pa.

PIPING, VALVES AND FITTINGS

29 **Hose couplings,** stems, swivels and accessories are listed in 32-p catalog 57. Includes photos, specs. J N Fauver Co, Inc, 51 W Hancock Ave, Detroit 2, Mich.

30 **Solenoid valves** are listed in 20-p catalog *200*. Discusses types, applications. Includes dimensions, specs. Atkomatic Valve Co, Inc, 545 W Abbott St, Indianapolis 25, Ind.

(*Continued on page 226*)

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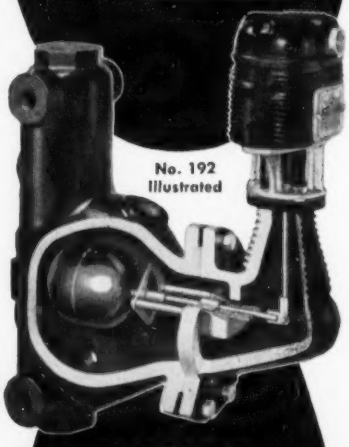

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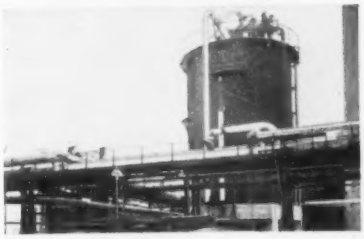

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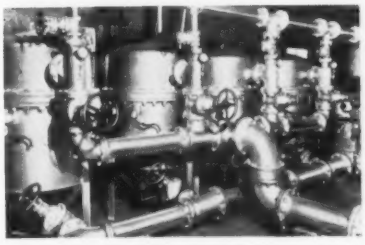

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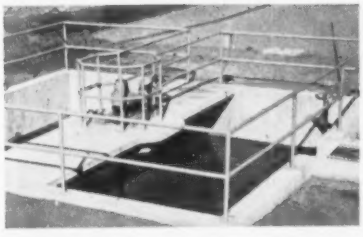

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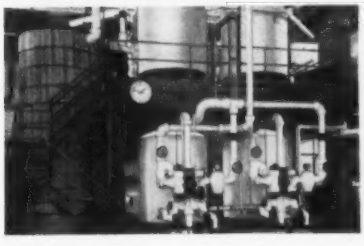

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Free literature

Begins on page 165

31 **Valves,** manually operated four-way hydraulic types, are listed in 12-p catalog *210.* Contains cross-sectional view of each model;; photos, specs. Rivett, Inc, Brighton 35, Boston, Mass.

32 **Technical data** card *TDC-115D* gives data from AISI Steel Products Manual. Includes info on dimensional tolerances on steel tubing. Tubular Products Div, Babcock & Wilcox Co, Beaver Falls, Pa.

33 **Quick coupler** for hoses, piping and equipment is described in 8-p catalog *F-10-R.* Includes features, applications, sizes. Jordan Industrial Sales Div of OPW Corp, 6013 Wiehe Rd, Cincinnati 13, Ohio.

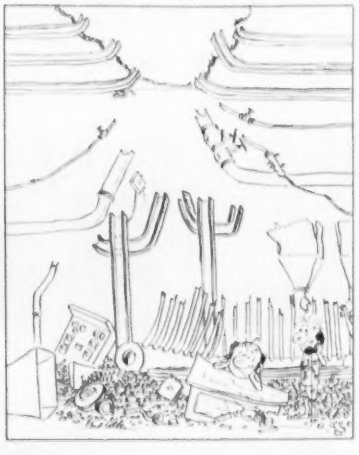
PUMPS

34 **Sump, process pumps,** heavy-duty vertical-centrifugal types, are covered in 12-p bulletin *726.2.* Includes specs, sectional views, performance ratings. Goulds Pumps, Inc, 40 Black Brook Rd, Seneca Falls, N. Y.

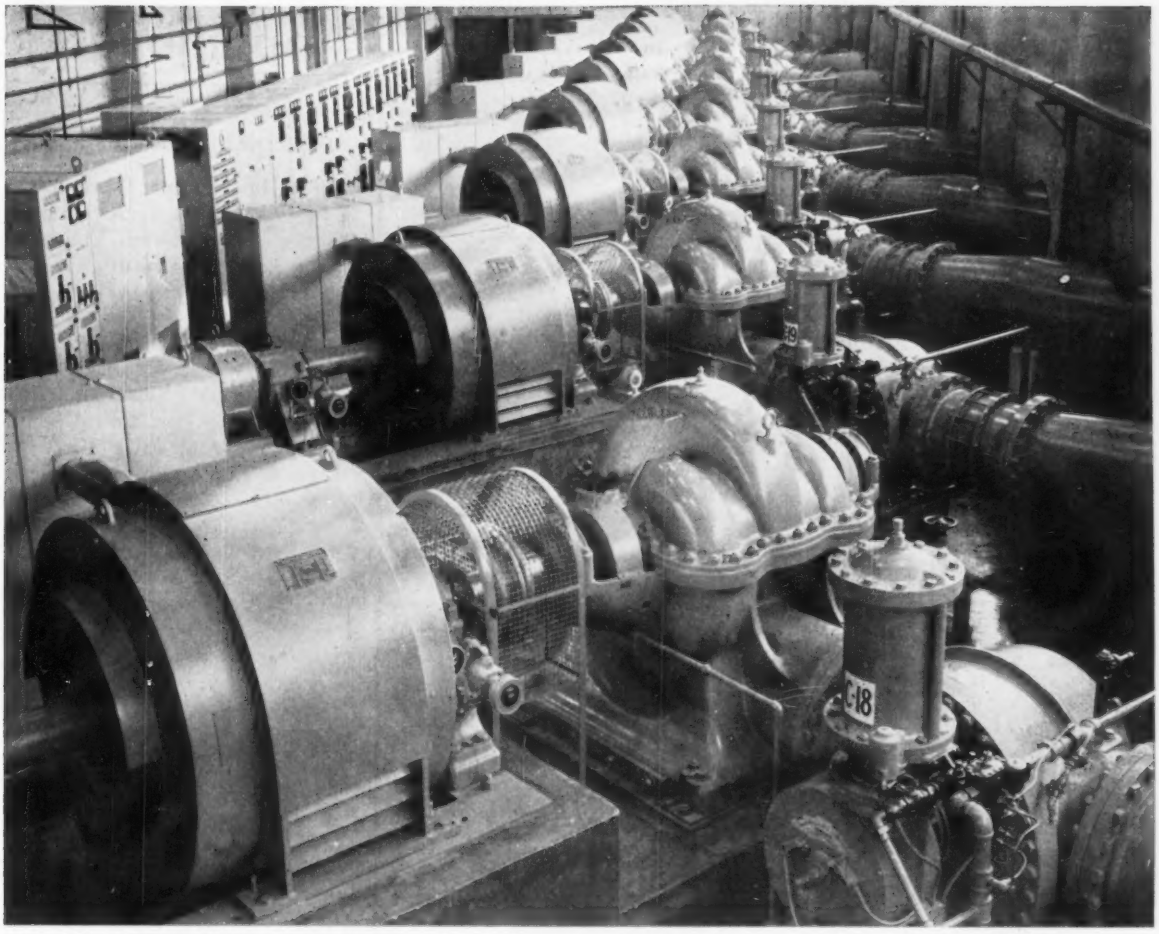
★ **Pump castings** are discussed in 20-p bulletin. Includes tables, photos. ★Request direct on company letterhead. Mechanite Metal Corp, 714 North Ave, New Rochelle, N. Y.

35 **Vacuum diffusion** pumps are subject of 12-p bulletin. Includes outline drawings, tables, speed curves for mercury and oil pumps. NRC Equipment Corp, Newton 61, Mass.

36 **High-pressure** screw pumps for various oil services at discharge pressures to 1000 psig, viscosities from 35 to 75,000 ssu are featured in 8-p technical bulletin *252.* Includes selection nomographs, dimensions. Warren Pumps, Inc, Warren, Mass.



"No, Ma'am . . . as far as we know there was no dog in it."



Eight 24" SMS-Rotovalves are used for pump check service at the Secondary Pumping Station of the U. S. Air Force's Arnold Engineering Development Center in Tullahoma, Tenn.* Installed on 25,000 GPM pumping units, each hydraulically-operated Rotovalve has independent timing control for opening and closing, and a by-pass fast closure device for shut down in the event of power failure. Four more 24" Rotovalves perform similar service at the Primary Pumping Station.

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SMS-Rotovalves' full-line opening offers no more resistance than straight pipe of the same diameter, means less head loss and lower pumping costs. Maximum initial shut-off, with retarded area reduction at the closing end of the stroke, controls water hammer. Opening and closing can be as fast as one second, or as slow as needed. Closure is drop tight, and monel-to-monel seats are self-purging.

You can obtain full information on SMS-Rotovalves, Ball Valves or Butterfly Valves by contacting our nearest representative. Or, write to S. Morgan Smith Co., York, Penna.

*Under construction by the Corps of Engineers, U. S. Army.

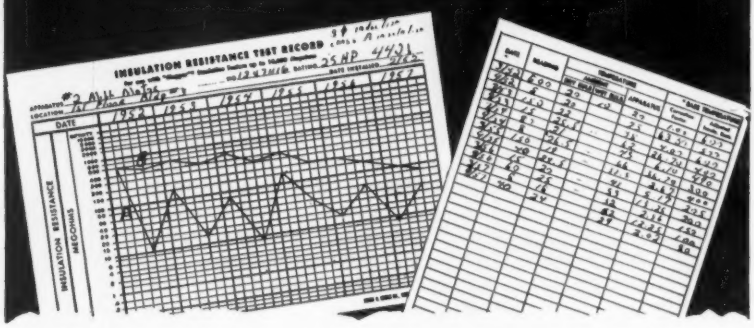
S. MORGAN SMITH — HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

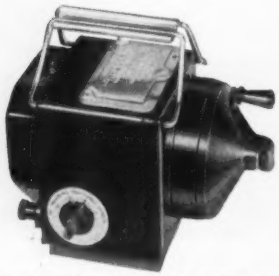
5

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

"A STITCH IN TIME" SAVES DOWNTIME



In other words, a "test in time" often avoids a costly machine outage, production loss and serious maintenance expense. The Test Record shown here is an example of how periodic measuring with a Megger® Insulation Resistance Tester gives you advance warning of impending trouble on an electric motor. This motor was repaired on a planned outage rather than under emergency conditions. Other dependable Biddle testing instruments are equally useful to detect trouble before it develops.



MEG® TYPE OF MEGGER INSULATION RESISTANCE TESTER— Available hand-operated, rectifier operated, or with a separate rectifier. Ranges up to 2000 megohms and 1000 volts d-c in all three models. BULLETIN 21-45 and 21-46-P.

MEGGER GROUND TESTER measures the resistance of earth to ground connections simply, easily and accurately, and thereby helps to determine whether such connections will perform the services for which they were designed & installed. BULLETIN 25-P.

SPEED MEASURING INSTRUMENTS — Frahm®, Jagabi®, Dr. Horn, Metron, Jones Tachometers, Jagabi Speed Indicator and Jagabi Tachoscope. There's a Biddle tachometer to suit every maintenance need—to check speeds accurately for load, friction, power transmission and lubrication. BULLETIN 35-P.

MEGGER LOW RESISTANCE OHMMETER — Battery or rectifier operated. Four ranges 0-1000 microhms down to 0 to 1 ohm. New clamp type test leads 18 ft. long enable one man to make tests. BULLETIN 24-46-P.

. . . serving your industry since 1895

B-805

JAMES G. BIDDLE CO.

Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

Appointments

Corporation changes

Taylor Instrument Companies: L Laurence Forward, Nathaniel B Nichols, Marc E Porter, William M Walters, Karl H Hubbard, Frank S Ward; vice-presidents. **H K Ferguson Co:** Norvon Clark, vice-president. **Bryant Mfg Co,** div of Carrier Corp: William M Day, Gordon N Gray, vice-presidents. **American Water Softener Co, Inc:** Alfred G Scattergood, president; Alfred G Zeigler, M H Love Jr; vice-presidents.

National Airoil Burner Co, Inc: John F Straitz Jr, president. **Norton Co:** William G Fallon, vice-president. **H K Porter Co, Inc:** Fred W Elliott, vice-president.

Operations changes

General Electric Co: Lewis J Burger, general manager of Gas Turbine Dept; John P Keller, general manager of Small Steam Turbine Dept. **Westinghouse Electric Corp:** Dr Clyde E Arntzen, manager of materials-engineering dept. **Allis-Chalmers Mfg Co:** E F Greiwe, manager of Norwood Works centrifugal pump dept.

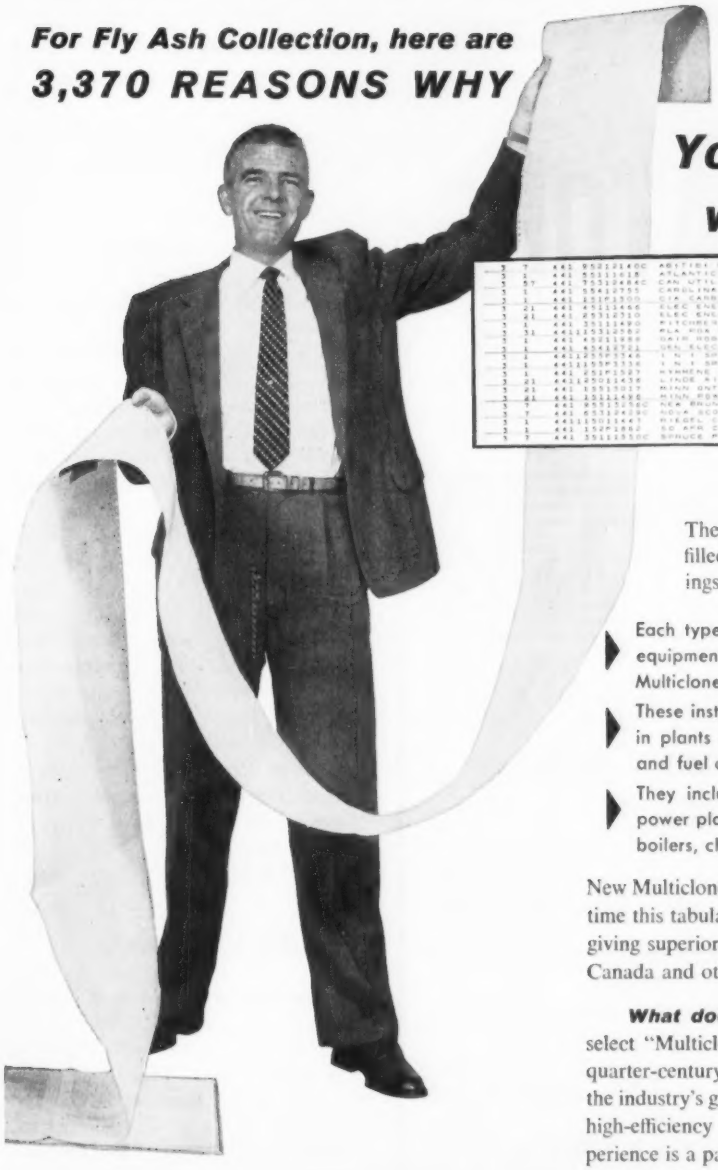
Robertshaw-Fulton Controls Co, Acro Div: Albert D Unetic, general manager. **Bailey Meter Co,** Atomic & Marine Div: H D Vollmer Jr, manager. **Graybar Electric Co, Inc:** R W Wright, operating manager at Jacksonville. **Norton Co:** William F Watts, factory manager of Refractories Div.

Interatom Internationale Atomreaktorbau GmbH: Dr Frank E Faris, general manager of technical dept. **Beckman Instruments, Inc,** Process Instruments Div: Stanford B Spracklen, associate director of research and engineering. **Orr & Sembower, Inc:** John A Tapparo, plant manager. **De Laval Steam Turbine Co:** Dr Karol Pilarczyk, director of research and development.

General sales manager

York-Shipley Inc, Jackson & Church Div: A W Pracker. **Allis-Chalmers Mfg Co:** Frank M Nolan, switchgear dept; Paul S Castner, Pittsburgh Works. **Farr Co:** Gordon F Thruelsen. **Crane Co:** Wil-

For Fly Ash Collection, here are 3,370 REASONS WHY



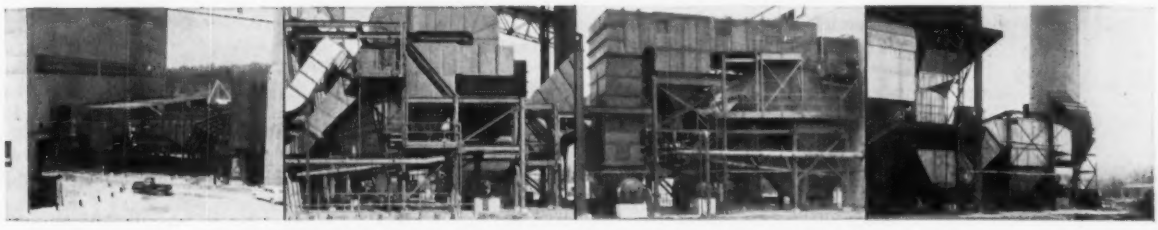
You're Years Ahead with MULTICLONE

The tabulation sheet shown here is over 40 feet long, filled top to bottom with single-spaced typewriter listings as shown in the enlarged section above...

- Each typewritten line tabulates an installation of Multiclone equipment—an installation of from one to nine separate Multiclone units!
- These installations have been made in all parts of the world, in plants operating under widely-varying load, atmospheric and fuel conditions!
- They include installations on virtually every type of steam power plant (i.e. pulverized coal fuel boilers, spreader stoker boilers, chain grate boilers, underfeed stoker boilers, etc.)

New Multiclone installations are being made every day, but at the time this tabulation was made there were 3,370 Multiclone units giving superior service to industry throughout the United States, Canada and other countries.

What does this mean to you? Simply this—when you select "Multiclone" you are getting equipment that has over a quarter-century of experience behind it...equipment backed by the industry's greatest fund of "know-how" in modern small tube, high-efficiency cyclonic collection. Although this unequalled experience is a part of every Multiclone installation, you pay nothing extra for this vital advantage!



Send For Descriptive Literature on Multiclone Equipment!

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
PRECIPITATION
CORPORATION

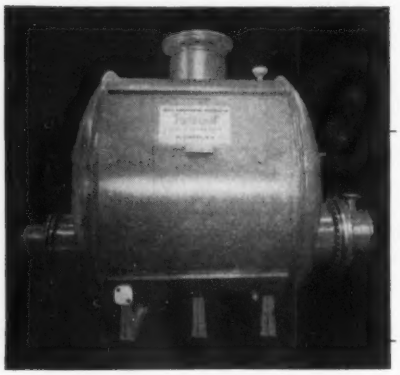
Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal

Paracoil EVAPORATORS



Paracoil Makeup Feed Water Evaporator now serving the City of Columbia, Missouri power plant. Consulting Engineers, Lutz and May, Kansas City, Missouri. Rated at 6,000 lbs. of steam per hour at 30 psia, with carry-over not exceeding 1 PPM. Built to ASME code requirements.

creatively engineered by Davis for installation in numerous public and private power plants

Davis Engineered Features

- All tubes and rolled tube joints can be hydrostatically tested without removing tube bundle.
- Tube bundle, with outside packed floating head, has free movement to allow for expansion and contraction.
- Any tube can be replaced without disturbing adjacent tubes.
- No internal steam connection or blind gasketed joints.
- Removable tube bundle.
- Pitched tube bundle to provide for complete drainage of condensate.
- Tubes arranged on wide square pitch to facilitate mechanical cleaning.
- Straight tubes of equal length to simplify tube stocking.
- Single-pass tube bundle for maximum free flow area of steam in tubes and minimum pressure drop through tube bundle.

Paracoil Evaporator Installations include the following:

Puerto Rico Water Resources Authority
Consulting Engineers: Jackson & Moreland, Boston, Massachusetts

Borough of Wellington, Connecticut
Alabama Electric Cooperative, Inc., Andalusia, Alabama
Consulting Engineers: Burns & McDonnell, Kansas City, Missouri

Western Electric Cooperative, Inc., Andarko, Oklahoma
Consulting Engineers: Laramore & Douglass, Inc., Chicago, Illinois

City of Bryan, Texas
City of Lafayette, Louisiana
Consumer's Public Power District, Ogallala, Nebraska
Consulting Engineers: Lutz and May, Kansas City, Missouri

Davis Makes it — Better! ***Write for Bulletin 1000***

DAVIS ENGINEERING CORPORATION

30 Rockefeller Plaza, New York 20, New York • Circle 6-5650

Appointments

Begins on page 228

liam O Brown. **Union Asbestos & Rubber Co,** Fibrous Products Div: Erle T Plummer.

District sales manager

Tube Turns Plastics Inc: Donald A Drake, southwestern district. **Nordberg Mfg Co,** Engine Div: H W Dow Jr, New York. **Reliance Electric and Engineering Co:** Charles D Herbert, eastern region; Emory G Orahood, southeast; William K Schlotterbeck, southwest; R O Herbig, central west.

Babcock & Wilcox Co, Boiler Div: William W Gilbert, Detroit. **Goulds Pumps, Inc:** W H Plowman, Tulsa; R L Tarnow, Chicago. **Link-Belt Co:** Bruce Mayo, Birmingham. **General Electric Co,** Assemblies and Components Sales: Arthur E Secker, Empire district; Robert A Else, Seattle.

Brown Bovari Corp: Allen C Conger, northwest region. **Manning, Maxwell & Moore, Inc:** Robert L Logan, midcontinent; L F Kirby, Atlanta; A H Barnes, Pacific coast.

New district offices

Sylvania-Corning Nuclear Corp: at 1811 Adrian Rd, Burlingame, Calif. **De Laval Separator Co:** at Minneapolis, Minn. **The Lima Electric Motor Co, Inc:** at 50 Church St, New York, N. Y. **Ketchum, MacLeod & Grove, Inc:** at 1000 Connecticut Ave, NW, Washington 6, D.C.

New names

Clark Controller Co: four new divisions: Automation; Packaged Drive & Control Centers; Crane & Mill Accessory Controls; Standard Products. **Fluor-Hartmann Div:** new division of Fluor Products Co to design, manufacture and sell Maschinenfabrik Hartmann A G equipment. **Corrosion Protection Services Co, Inc,** 507 Fifth Ave, New York City: new service company. **Drexelbrook Consulting Service,** 1417 Edgehill Rd, Abington, Pa: new firm in automation field.

Stretch Wire Corp: extensible

Carpenter

Welded Stainless Pipe
available from large
local stocks . . . real cost savings
at a time when costs are
hard to cut . . .

• Carpenter Welded Stainless Pipe saves you money on initial cost, but that's only the beginning. Because it's consistently more uniform, Carpenter Stainless Pipe provides service benefits that increase effective corrosion resistance and give longer life. Schedule 5, 10 and 40 stainless pipe is stocked by your nearby Carpenter distributor in quantities that assure you immediate delivery. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Carpenter

more than corrosion resistance

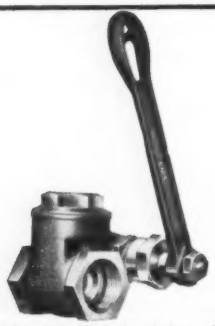
Stainless Pipe

FOR YOUR VALVE REQUIREMENTS

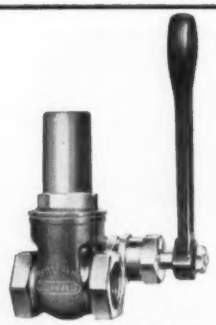
Source	**DETROIT CONTROLS**
Brand	D.T. **Williams**
Type	Lever Handle Gate Valves—all top quality. For full information write for Catalog 800.
Specifications	Meet all government, marine and industrial specifications.

No. 130 Quick and full straightway opening and closing with short movement of lever. For steam pressures to 100 lbs. and air or liquids to 150 lbs., up to 500° F. Medium bronze construction, with malleable iron lever handle.

No. 131 Short movement of lever gives quick and full straightway opening. For steam pressures to 200 lbs., and air or liquids to 300 lbs., up to 500° F. Heavy bronze construction. Lever handle of malleable iron.



No. 736 "Quik-flo" Valve. Heavy bronze construction and suitable for wide application. For hazardous liquids; listed by Underwriters' Laboratories, approved by Factory Mutual. Steam pressures to 125 lbs. and air or liquids to 200 lbs., up to 450° F. Malleable iron handle.



No. 835 "Quik-flo" Valve. Self-closing and of heavy bronze construction. Designed for controlling hazardous liquids; approved by Factory Mutual. For steam pressures to 125 lbs., and air or liquids to 200 lbs., up to 450° F. Lever handle of malleable iron.

Quality Protects Your Investment--

AMERICAN-Standard Quality Is Available At No Extra Cost.

Bridgeport 1, Connecticut

DETROIT CONTROLS

Division of AMERICAN-Standard

Appointments

Begins on page 228

cables for the electrical industries. **Haydon Instrument Co:** design and manufacture of electro-mechanical devices. **General Electric Co,** Atomic Power Equipment Dept: new Marketing and Project section headed by J Emmett Maider.

Institute Elections

American Society of Heating and Air-Conditioning Engineers: Elmer R Queer, president; Arthur J Hess, first vice-president. **National Association of Corrosion Engineers:** L L Whiteneck, president. **Cooling Tower Institute:** Karl E Johnson, president. **American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc:** Dr Augustus B Kinzel, president.

Awards

John K Hodnette received the 1957 Edison Gold Medal of the AIEE. **M E Talaat:** received first prize for best paper in Power Div of AIEE. **Carl F Kayan:** was made a Fellow of the American Society of Heating and Air-Conditioning Engineers. **Joseph C Rengel, Alexander Squire, William R Ellis, William H Hamilton, Nunzio J Palladino** and **Lloyd B Kramer** were awarded the Westinghouse Order of Merit for work on the atomic submarine and Shippingport projects.

Obituaries

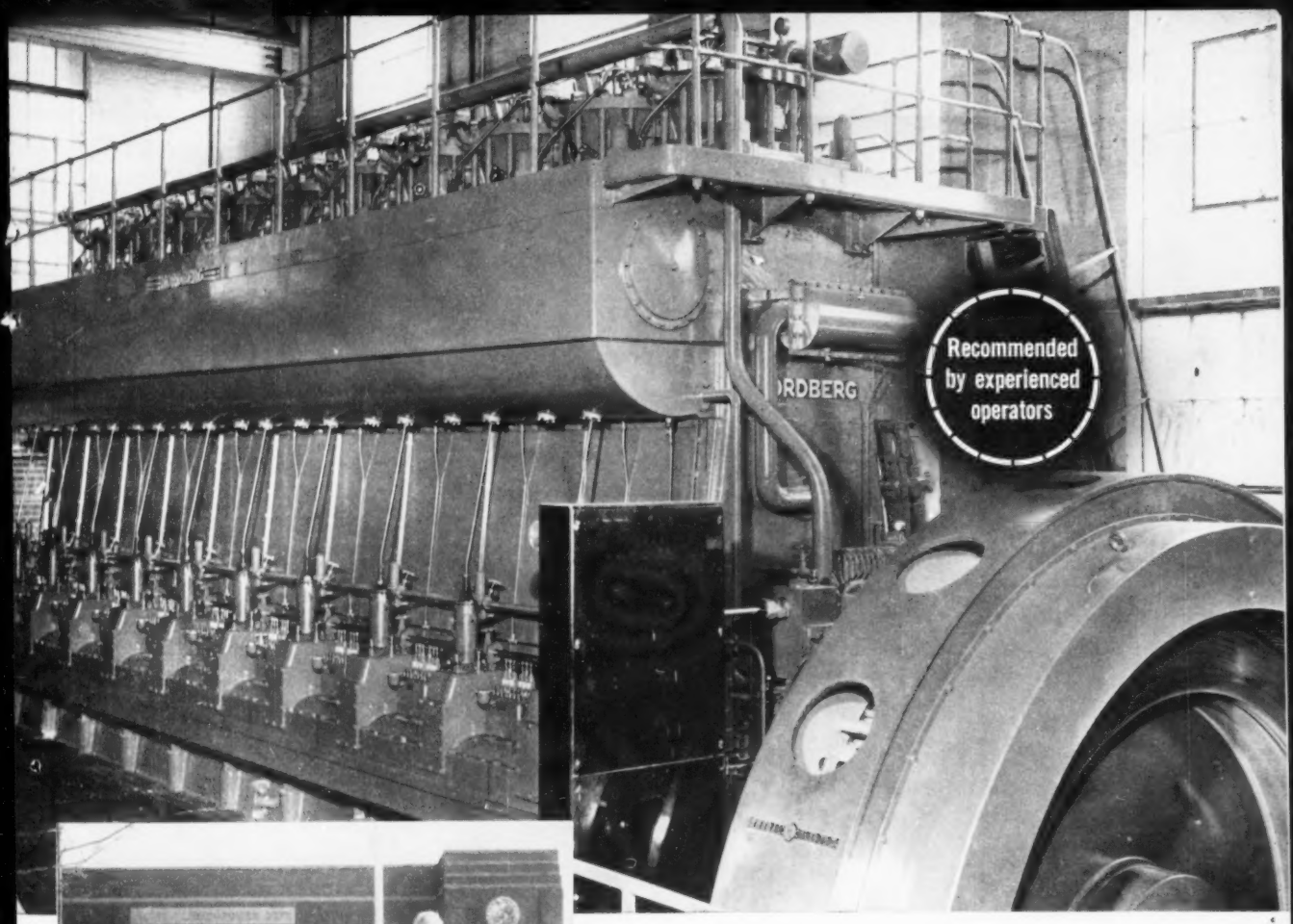
John H Merrell, honorary director of Raybestos-Manhattan, Inc, on January 4.

Frank X Gilg, 57, executive assistant in the Boiler div of The Babcock & Wilcox Co, on January 26.

Charles H Kibler, 58, general traffic manager, manufacturing dept, of Boiler div of The Babcock & Wilcox Co, on February 3.

Harrison W Marshall, 59, vice-president of Buensod-Stacey Inc, on February 14.

Dr. Ovid Wallace Eshbach, Professor of Engineering Sciences at the Northwestern University Technological Institute and its first dean, died on March 3. A Fellow of the AIEE, Dr Eshbach was 64 years old.



Mr. Thomas A. Walsh, Manager, Light & Power Department, Hudson, Mass., says:

"I honestly feel you can't beat a Nordberg . . ."

Mr. Walsh writes: *"Our first Nordberg ran 32,555 hours in four years of operation. Naturally, when we were in the market for another engine we chose another Nordberg. This new engine, a 'duafuel', has only been in operation for a year and a half, and it, too is a 'work-horse' like our other Nordberg. I honestly feel you can't beat a Nordberg for conditions like ours."*

And conditions at Hudson, Mass. are very similar to scores of municipal light and power plants in all parts of the country . . . where economical, reliable, around the clock power is needed to meet the ever-increasing electrical demands. That's why there are so many *repeat orders* for Nordberg Diesel, Duafuel®, and Spark-Ignition Gas engines, from experienced operators like Mr. Walsh. Next time, consult Nordberg on *your* power study . . . builders of America's largest line of heavy duty engines.

NORDBERG MFG. CO., Milwaukee, Wisconsin

Installation Data:
City of Hudson, Massachusetts

Two Nordberg 2-cycle engines of 21½" bore installed, totaling 9350 bhp:

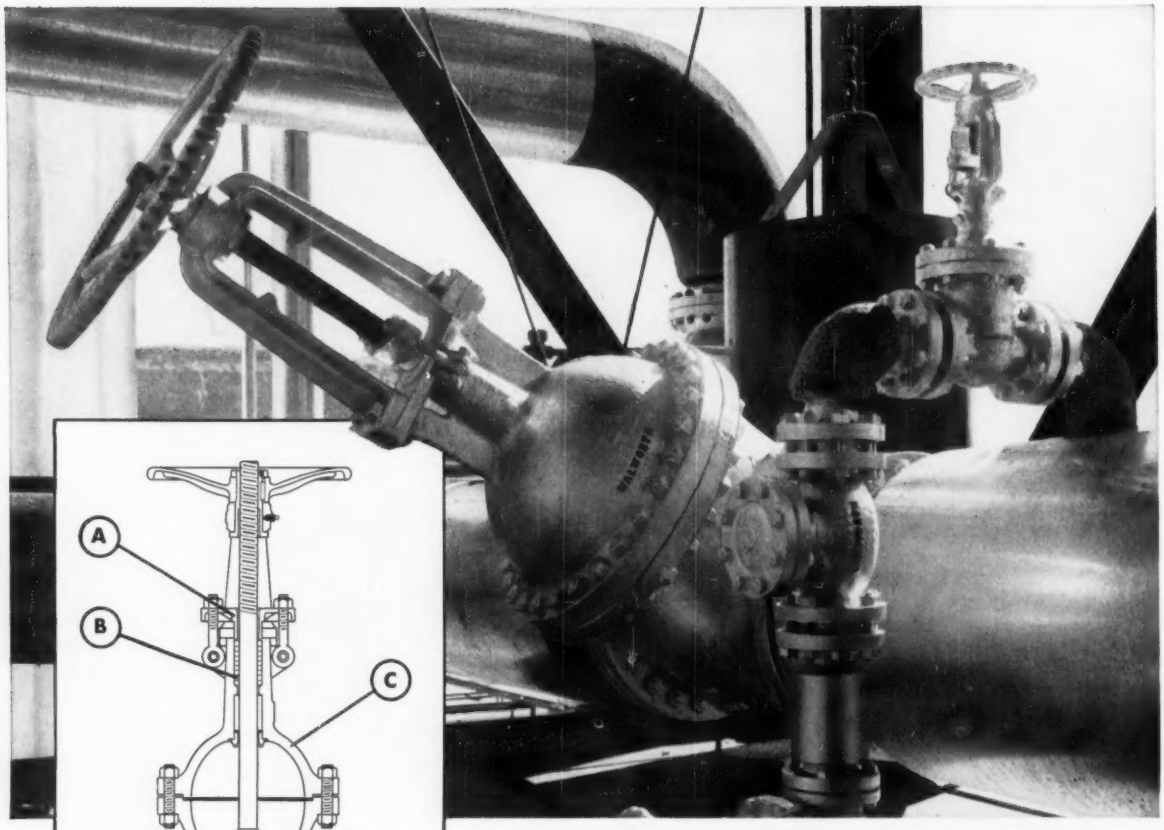
- First engine, a 10-cylinder Nordberg Diesel unit, rated 4250 bhp.
- Second engine, a 10-cylinder Nordberg Duafuel® unit, rated 5100 bhp.

NORDBERG

DIESEL • DUAFUEL® AND SPARK IGNITION GAS ENGINES

© 1957, Nordberg Mfg. Co.

P857



Walworth Series 150 and 300

CAST STEEL GATE VALVES OFFER YOU THESE FEATURES

for 'round-the-plant service

(A) GLANDS: Clearances between the gland and stuffing box, and gland and stem, are such that the stem cannot be scored even if the gland is pulled down unevenly.

(B) DEEP STUFFING BOXES: More than adequate in all sizes (2″ to 24″) to assure tightness and maximum packing life.

(C) BONNETS AND BODIES: Engineered to exceed the requirements of all applicable codes and standards. They are tough, durable, dependable.

(D) INTEGRAL GUIDE RIB FACES IN BODY: Machined to insure accurate centering of the gate.

(E) STURDY SEAT RINGS: Bottom-seated so that no recess exists at the back of the ring to cause turbulence, erosion and pressure drop.

(F) STREAMLINED PORTS: Permit unobstructed flow which results in minimum pressure drop and reduces the possibility of erosion.

Walworth Cast Steel Gate Valves can be furnished with either flanged ends or butt welding ends. Roller bearing yokes are available on the larger sizes. On valves 4 inches and larger, by-passes can be furnished. Walworth Cast Steel Gate, Globe and Check Valves from Series 150 to 2500, are available. For Series 600 and higher, we recommend Walworth Pressure Seal Cast Steel Valves. See your Walworth Distributor or write to Walworth for complete information.

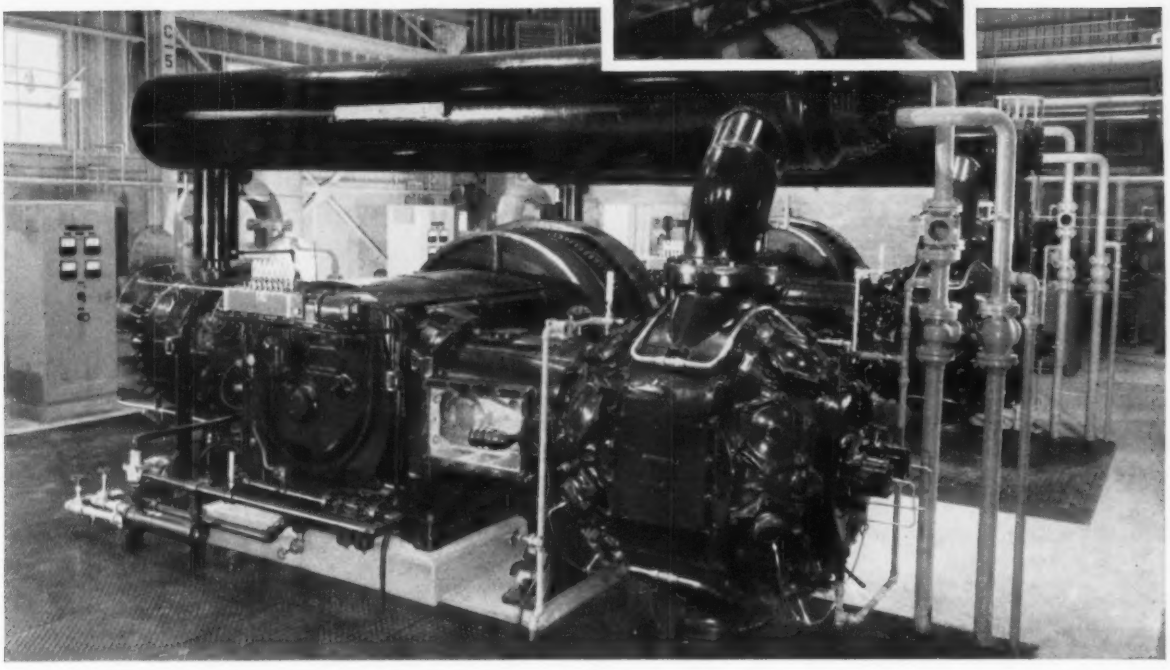
WALWORTH

750 Third Avenue, New York 17, New York

SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION M&H M & H VALVE & FITTINGS CO.
SW SOUTHWEST FABRICATING & WELDING CO., INC. WALWORTH COMPANY OF CANADA, LTD.

NATURAL BALANCE...

for smoother compressor performance



In Cooper-Bessemer industrial air compressors, just as in nature, forces oppose forces, resulting in the smoothest compressor performance imaginable. So we call it Natural Force Balance . . . and it has a lot of bearing on compact design, continuous availability, and prolonged low cost of shop air supply!

If you plan on new or expanded plant air facilities, by all means send for new Bulletin M-81, "Air for Industry". It covers Cooper-Bessemer M-Line compressors, 200 to 10,000 hp, and tells you about the advantageous *new* things being done by one of America's *oldest* engine and compressor builders.

Cooper/Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE OR MOTOR DRIVEN

Here's a pump you can use anywhere GOULDS self-priming centripetal pump (Fig. 2520)

pumps liquid... air ...liquid and air

As a scavenger . . . handy transfer . . . for cleaning up—which way can this versatile Goulds pump work for you?

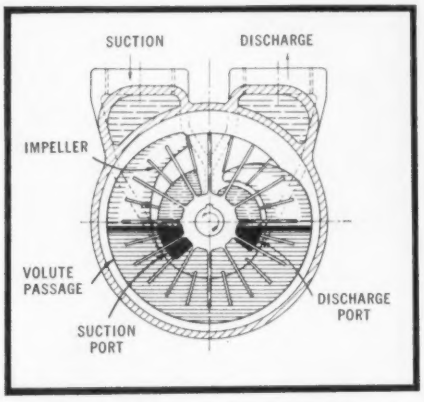
You can use it for almost anything.

Because it pumps air and liquid in any combination, it handles foaming solutions and emulsions easily. It's ideal for pilot plant work, for cleaning operations.

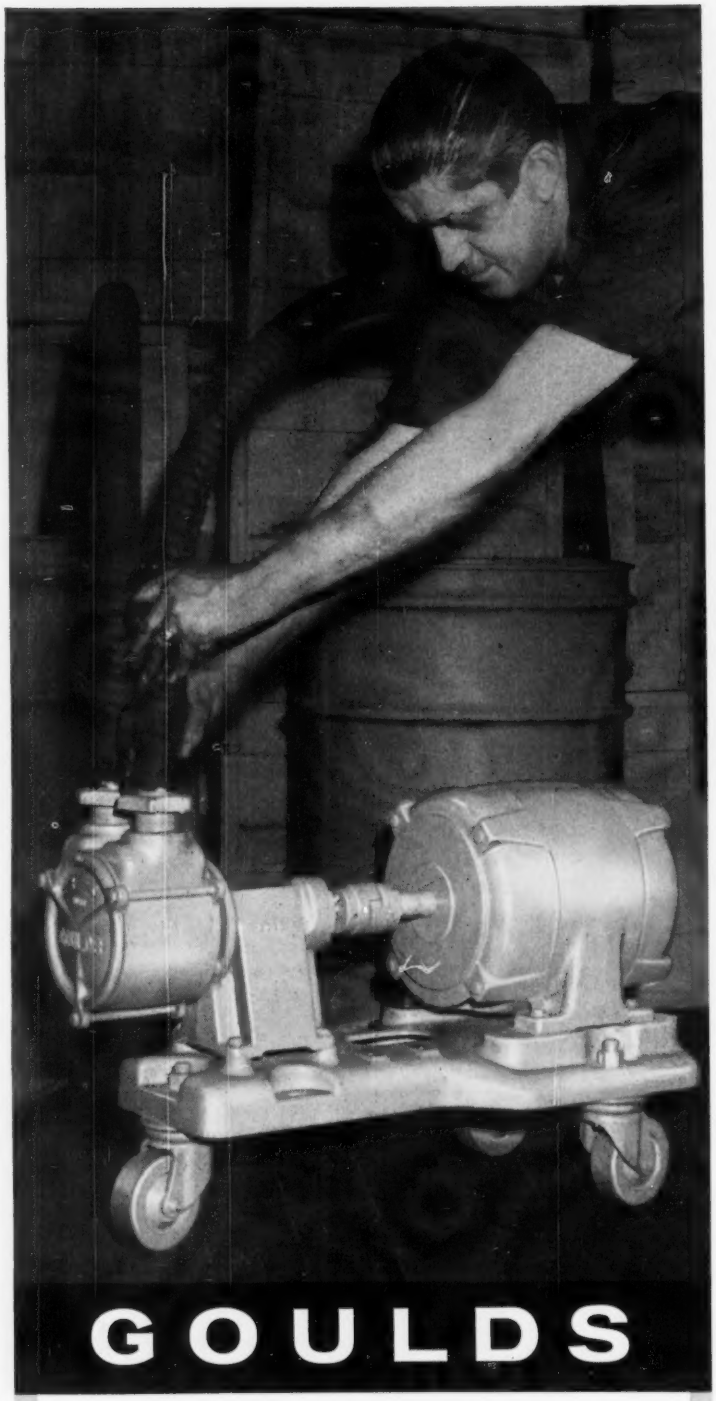
Once primed, it stays primed. It won't air-bind. Even with loops or leaks in your suction line, its high air-handling capacity will keep liquids moving.

Compact, lightweight, portable—it's ready in all-iron construction, or in stainless steel for corrosive service. It's offered as a mobile unit (illustrated), pump-motor unit, or pump only for V-belt drive. The pump itself weighs 42 pounds. With 1½ inch suction and discharge, capacities go to 60 GPM, heads to 80 feet.

There's a complete description of the Liquid Ring Pump in Bulletin 725.6; you can get a copy from us or from your Goulds representative.



This new self-priming Goulds pump eliminates air-binding by a unique use of *centripetal* action. The impeller forces liquids along a volute casing, building up pressure as the liquid moves to the narrow end. This pressure sets up a liquid piston action between each set of blades, forcing liquids to the center of the pump. The liquid piston forces any air entrapped in the center up through the outlet.



pumps for industry

GOULDS PUMPS, INC.

Main Office and Works, Seneca Falls, New York

Branches and Representatives in principal cities

In Canada: The A. R. Williams Machinery Co., Ltd.

Developed by ALCO *thermal engineers, this sine-wave tube configuration has pioneered atomic heat-exchanger design.*

THE NEW SHAPE OF THERMAL EXPANSION

Some heat exchangers in atomic power plants are exposed to tremendous fluctuations in temperature. This means, of course, that unusual expansion characteristics must be provided. ALCO engineers have answered this need by designing a unique sine-wave tube that eliminates expansion joints and floating tube-sheets.

Originally designed for America's first atomic submarine, the *Nautilus*, this new concept is currently being applied in other ALCO heat exchangers for major nuclear power plants. The design itself is simple, but it safely absorbs thermal and shock loads through the flexing of the tubes' sine-wave bends.

This new shape of thermal expansion is typical of the advanced design concepts that ALCO builds into all its heat transfer equipment. As a leader in heat exchangers for the power industry, ALCO is now pioneering in the field of thermal engineering for the atomic industry.

For complete information, contact your nearest ALCO sales office or write: ALCO Products, Inc., Dept. 133, Schenectady, N.Y.

ALCO

ALCO PRODUCTS, INC.

NEW YORK

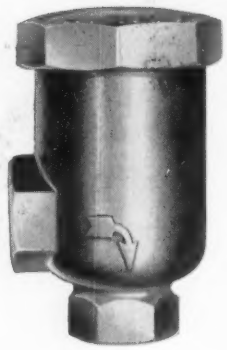
SALES OFFICES IN PRINCIPAL CITIES

Locomotives · Diesel Engines · Nuclear Reactors · Heat Exchangers · Springs · Steel Pipe · Forgings · Weldments · Oil Field Equipment

need steam traps?

name the way you want them!

TYPE A



TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

Sizes: A—from $\frac{1}{4}$″ to 1″. D—from $\frac{1}{4}$″ to $\frac{3}{4}$″. C—from $\frac{1}{2}$″ to 2″.

Materials: Cast Iron, Cast Steel and Bronze.

Pressures: A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

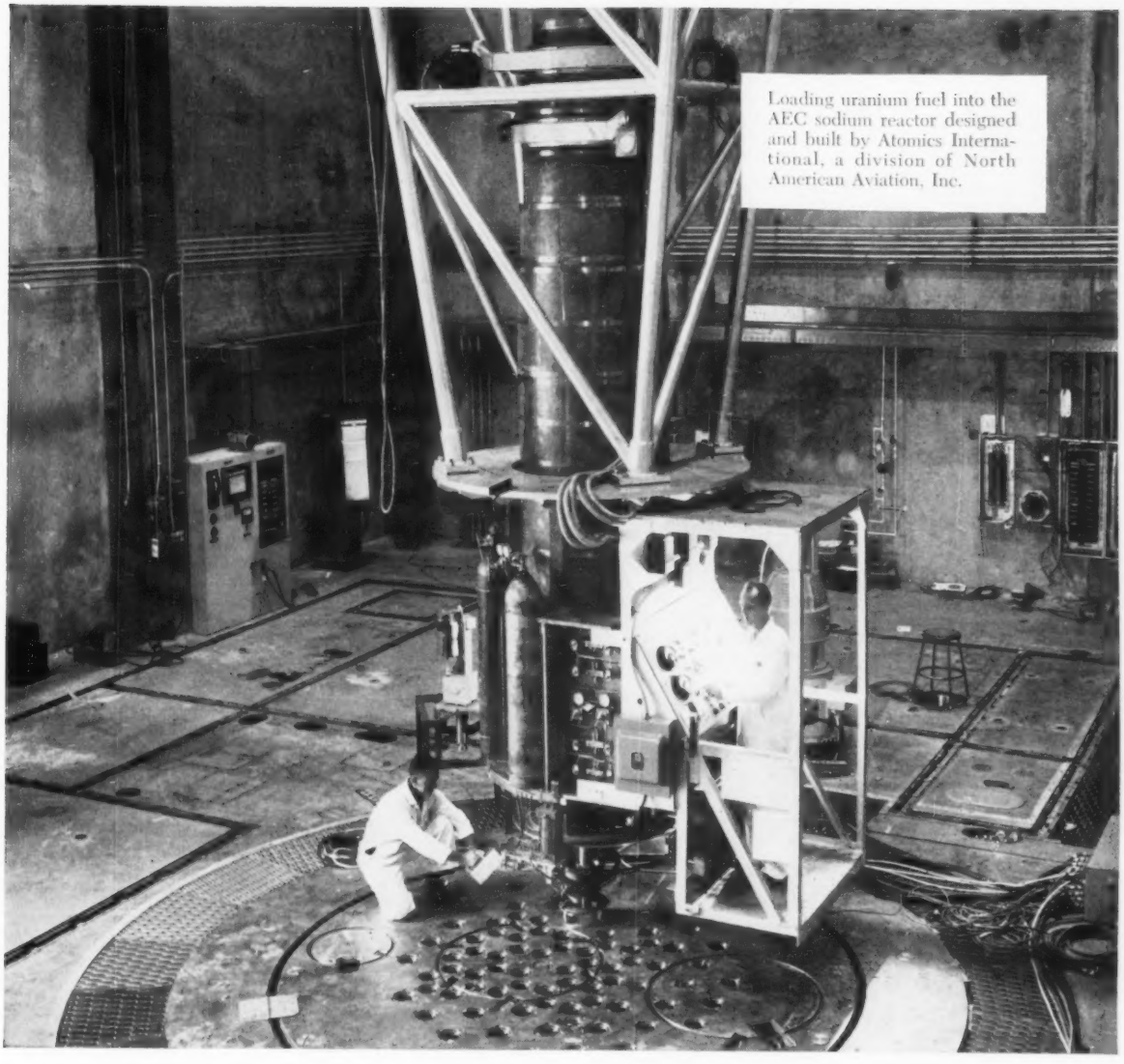
Capacities: From two to six times greater orifice area and capacity than other traps of comparable size.

Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre



Loading uranium fuel into the AEC sodium reactor designed and built by Atomics International, a division of North American Aviation, Inc.

Water for new Atom Power Plant is 99.999992% pure!

● Southern California Edison Co. . . . now generating current from this new reactor in the Santa Susana Mountains . . . is the first private utility to produce electricity from a non-military reactor.

As in any system using water or steam in or near an atomic reactor, the quality of the water at the Santa Susana plant is important. Suspended and dissolved mineral solids must be removed to prevent them from depositing in boiler tubes and turbines. In other types of reactors, these solids can also pick up and carry radioactivity and could make turbines and other equipment difficult for maintenance or repair.

Although this plant's water supply is a clear well water, it contains almost 600 parts per million of hardness salts and other dissolved solids. The Permutit softener and demineralizer reduce these solids to 1/12 part per million . . . a purity of 99.999992%!

Permutit was chosen to design and supply this precise and critical equipment because of its long experience in water conditioning.

If your problem is Water . . . for industrial, municipal or home use, we'd like to discuss it with you. Address: The Permutit Company, Dept. P-4, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

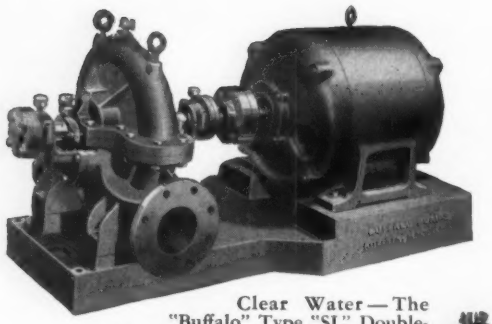
PERMUTIT®

rhymes with "compute it"

a division of PFAUDLER PERMUTIT INC.

Water Conditioning

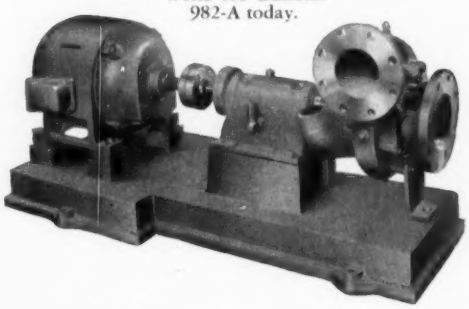
Ion Exchange • Industrial Waste Treatment

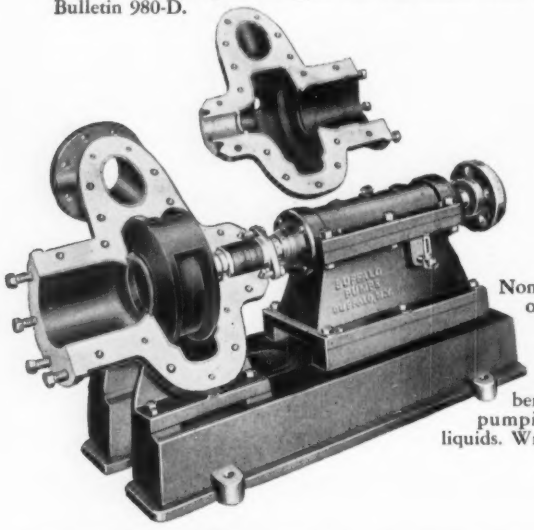


Clear Water — The "Buffalo" Type "SL" Double-Suction Pump is recognized for its highly efficient clear water service throughout industry. Capacities from 10 to 14,000 gpm. Write for Bulletin 955-R.

High Pressure — The "Buffalo" Type "RR" Multi-Stage Pump is ruggedly engineered to deliver peak efficiency on boiler feed and other clear water applications against heads as high as 1500 feet. Capacities range up to 900 gpm. For full details write for Bulletin 980-D.

Chemical Liquids — The complete "Buffalo" line includes ten specially designed pumps for chemical liquids. Available in several types of construction for handling a wide variety of corrosive, abrasive or high-consistency liquids. Write for Bulletin 982-A today.





Non-Clogging — "Buffalo" Diagonally Split-Shell Pumps are designed for moving high-consistency liquids, with down-time reduced to an absolute minimum. A number of models are available for pumping abrasive and corrosive liquids. Write for Bulletin 953-K.

WHATEVER YOUR LIQUID-MOVING PROBLEM, THERE'S PROBABLY A "BUFFALO" PUMP TO SOLVE IT!

And the fact that "Buffalo" builds a *complete line* of pumps — a type, size and capacity to fit almost every liquid-moving need — can save you money right from the start. It means you never need to pay for "more pump" than you actually require.

You'll find a "Buffalo" Pump to match your exact requirements, with complete assurance of the utmost efficiency, dependability, ease of maintenance and long-range economy. Just contact your nearest "Buffalo" engineering representative, or write us direct. We'll be glad to recommend the pump that's best-suited to your needs.

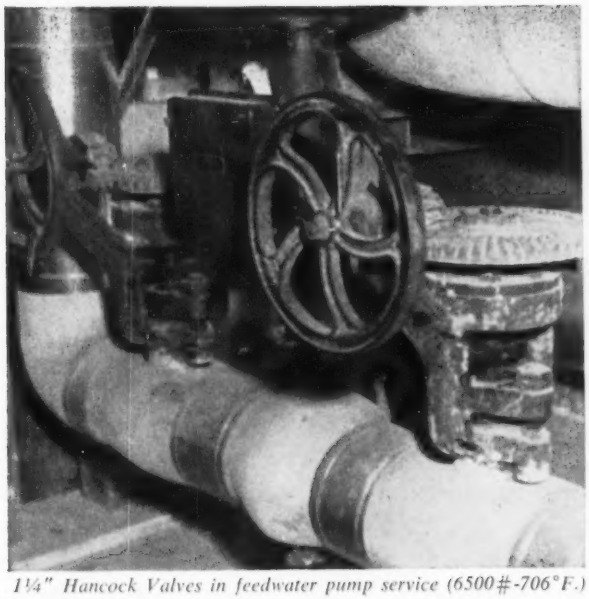
THE COMPLETE "BUFFALO" LINE ALSO INCLUDES: Heat Transfer Pumps, Close-Coupled Pumps, Sump Pumps and Raw Sewage Pumps. Special alloys available in all models.

Engineered into every "Buffalo" Pump is the famous "Q" Factor — the built-in QUALITY which provides trouble-free satisfaction and long life.

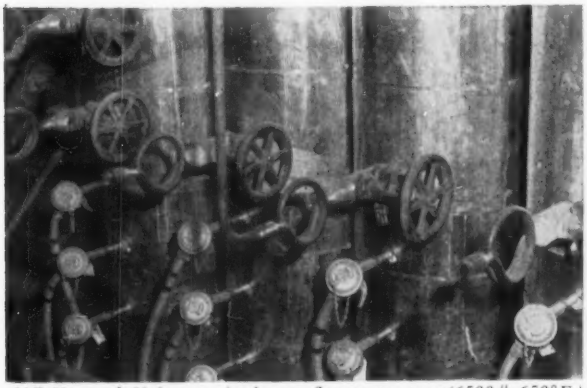
BUFFALO PUMPS
DIVISION OF BUFFALO FORGE CO.
488 Broadway • Buffalo, N. Y.
Canada Pumps Ltd., Kitchener, Ont.
Sales Representatives in All Principal Cities

"Buffalo" PUMPS

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



1¼" Hancock Valves in feedwater pump service (6500#-706°F.)



¼" Hancock Valves on feedwater flow meter taps (6500#-650°F.)

¼" Hancock Valves on main instrument lines (5000#-1150°F.)

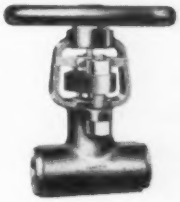
VALVE DURABILITY
MATCHES
SUPERCRITICAL PRESSURES

Rated at 5000#-1150°F., Hancock Valves were selected for the new unit of the Philo Plant of Ohio Power Co. where boiler operation is at pressures and temperatures above the critical. *Stay-in-the-line durability* explains why design engineers and steam plant operators prefer these valves for feedwater service, drips, drains, vents and other piping.

Hancock Valves are easily serviced in the line. The bonnet is permanently welded to the body. No bonnet joint to leak. No seal weld to cut—no danger of damage to internal parts. The stellite seat is integral. No seat joint to leak. Seat refinishing is quick and easy with a power drill and reseating tool. The stellite disc is replaceable. The stem resists galling, erosion, thread wear; inhibited packing prevents stem pitting. No need for destructive "cheater" loading—handwheel operation is easy, closure positive against full rated pressure.

Protect personnel, plant and service to customers with durable Hancock Valves. Ask your nearby industrial supply distributor for complete details.

Sizes: ½" thru 2". OS&Y. Service Ratings: For all pressures up to 5000 psi at 1150°F. Weld Ends.



MANNING MAXWELL & MOORE INC. TRADE MARK

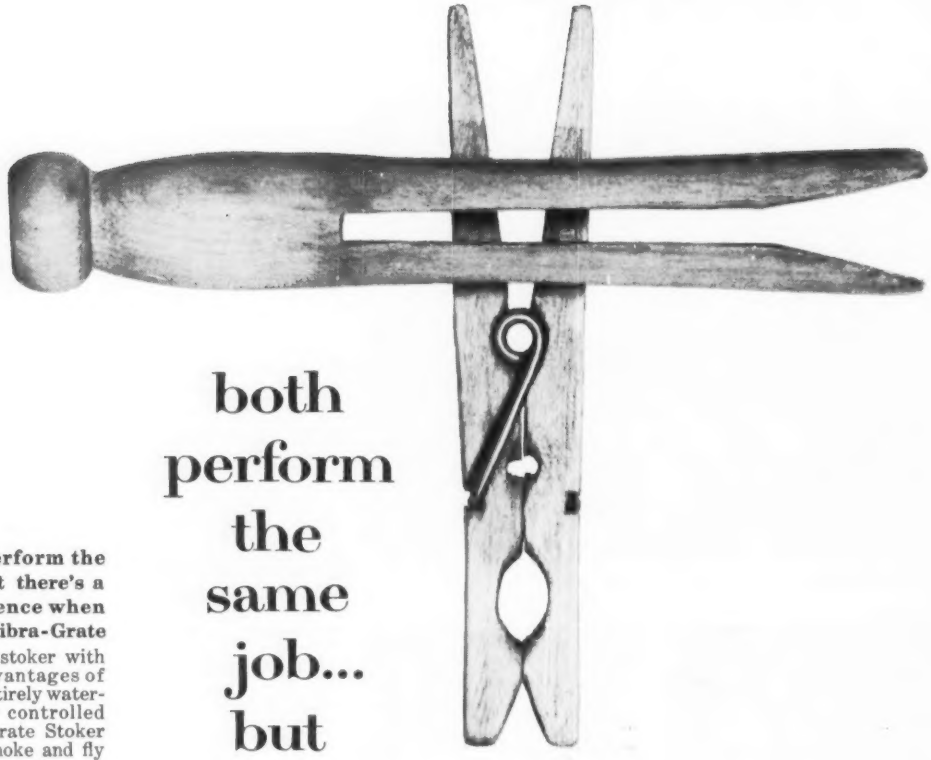
H4-58

HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



both perform the same job... but there's a difference!

Steam plants all perform the same job, too . . . but there's a very decided difference when you choose AE's Vibra-Grate Stoker. For here's a stoker with everything . . . the advantages of others rolled into one entirely water-cooled, automatically controlled unit. The AE Vibra-Grate Stoker gives freedom from smoke and fly ash at both high and low ratings . . . eliminates need for dust collectors and cinder return systems . . . burns low-grade coals efficiently . . . is readily adaptable for burning gas or oil either singly or in combination with coal.

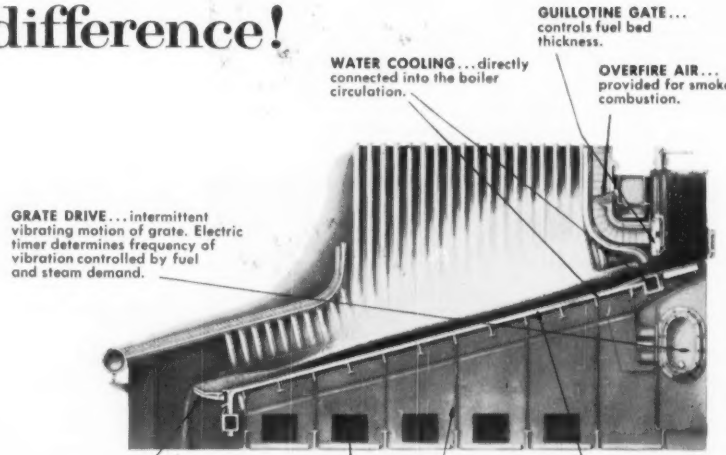
The Vibra-Grate Stoker feeds and moves the fuel automatically by intermittent vibrating motions, insuring even distribution and avoiding holes and light spots in the fuel bed. Its highly effective water-cooling system guarantees long grate life with proved maintenance of less than 2/10 cents per ton of coal burned.

The Vibra-Grate is years ahead in design efficiency, yet its over-all cost is low. If you're thinking of adding a new power plant or modernizing your present one, write today for details of the Vibra-Grate . . . you won't be disappointed.

Other outstanding stokers made by American Engineering Company are:

TAYLOR STOKER: an underfeed stoker for power requirements ranging from 20,000 to 500,000 pounds.

PERFECT SPREAD STOKER: a spreader stoker with spiral-type rotors and continuous chain feeders for both lateral and longitudinal coal distribution.

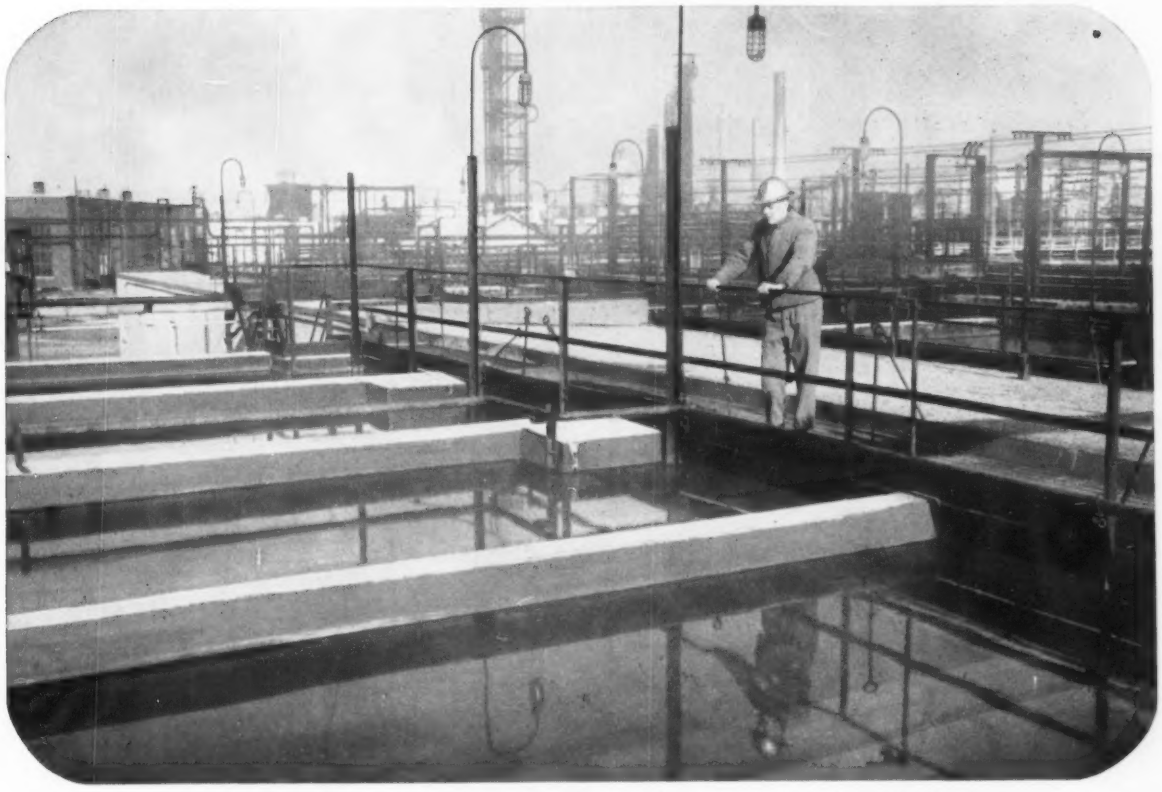

GUILLOTINE GATE... controls fuel bed thickness.
WATER COOLING... directly connected into the boiler circulation.
OVERFIRE AIR... provided for smokeless combustion.
GRATE DRIVE... intermittent vibrating motion of grate. Electric timer determines frequency of vibration controlled by fuel and steam demand.
ADJUSTABLE ASH DISCHARGE... retards ash discharge until complete combustion is effected.
DAMPER CONTROLLED AIR INLETS
GRATE SUPPORT... flexibly supported on division plates forming the zoned air sections of the windbox.
TUYERES... air supplied to fuel bed through high-resistance grate formed of tuyeres, embracing water-cooled grate tubes... insuring long grate life.

AMERICAN ENGINEERING COMPANY

Wheatsheaf Lane and Sepviva Street S-100
Philadelphia 37, Pennsylvania

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q., Bawden Industries Ltd., Toronto, Ont.

ION EXCHANGE RESINS for water conditioning



This open-tank softener has been in continuous service since 1950 using its original AMBERLITE IR-120 resin.

AMBERLITE IR-120 in use over 7 years at oil refinery has treated 3,000,000 gallons of water per cubic foot of resin . . . shows no significant change in softening capacity.

That's the outstanding record of the AMBERLITE IR-120 ion exchange resin in use at the Gulf Oil Corporation's refinery in Philadelphia, Pa.

This refinery can produce 3,000,000 pounds of 200 and 680 psi steam every hour for electrical power generation, heat exchange and process use. All the water used is taken from the Schuylkill River and, after preliminary treatment, is conditioned to remove all calcium and magnesium hardness. AMBERLITE IR-120, a strongly acidic cation exchange resin operating in the sodium cycle, is used effectively and economically in the refinery's open bed, gravity-feed softeners to condition 600,000 gallons of water per hour to less than 1 ppm. of hardness.

The AMBERLITE IR-120 at the Gulf Oil Corporation's Philadelphia refinery has been in constant use since 1950 without significant change in capacity or loss of resin—and each cubic foot of resin has treated well in excess of 3,000,000 gallons of water.

While there are many installations which have given such prolonged service, the durability of ion exchange resins is dependent upon the nature of the influent water supply and operating conditions. Engineering companies specializing in water treatment are qualified by experience to give you recommendations on how AMBERLITE ion exchange resins can best serve your specific needs.

Whether you need softened, deionized, dealkalized or deacidified water, ion exchange provides a practical and effective answer to your water conditioning problems. Write for our booklet "If You Use Water" for full information about AMBERLITE resins.

AMBERLITE is a trade-mark, Reg. U.S. Pat. Off. and in principal foreign countries.

Chemicals for Industry

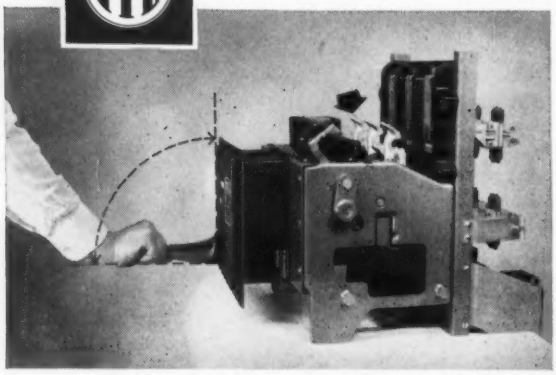
ROHM & HAAS COMPANY

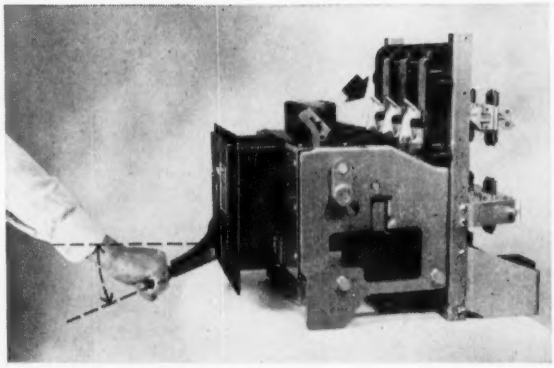
THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

Representatives in principal foreign countries

K-LINE LOW VOLTAGE SWITCHGEAR





Only I-T-E has manual quick-make operation available in 225 through 1600 amp rating

Only handle moves. Contacts are static during first 90% of pulldown handle travel. In this picture, arc chutes are removed.

Too fast for the eye. When stored energy mechanism passes crossover point, energy is released to close contacts within 5 cycles.

Only I-T-E has doors closed in all positions while racking

With breaker connected. Both power and control separable contacts are engaged.

In test position. Power contacts disconnected —control contacts connected.

Completely disconnected. Both power and control contacts fully disconnected.

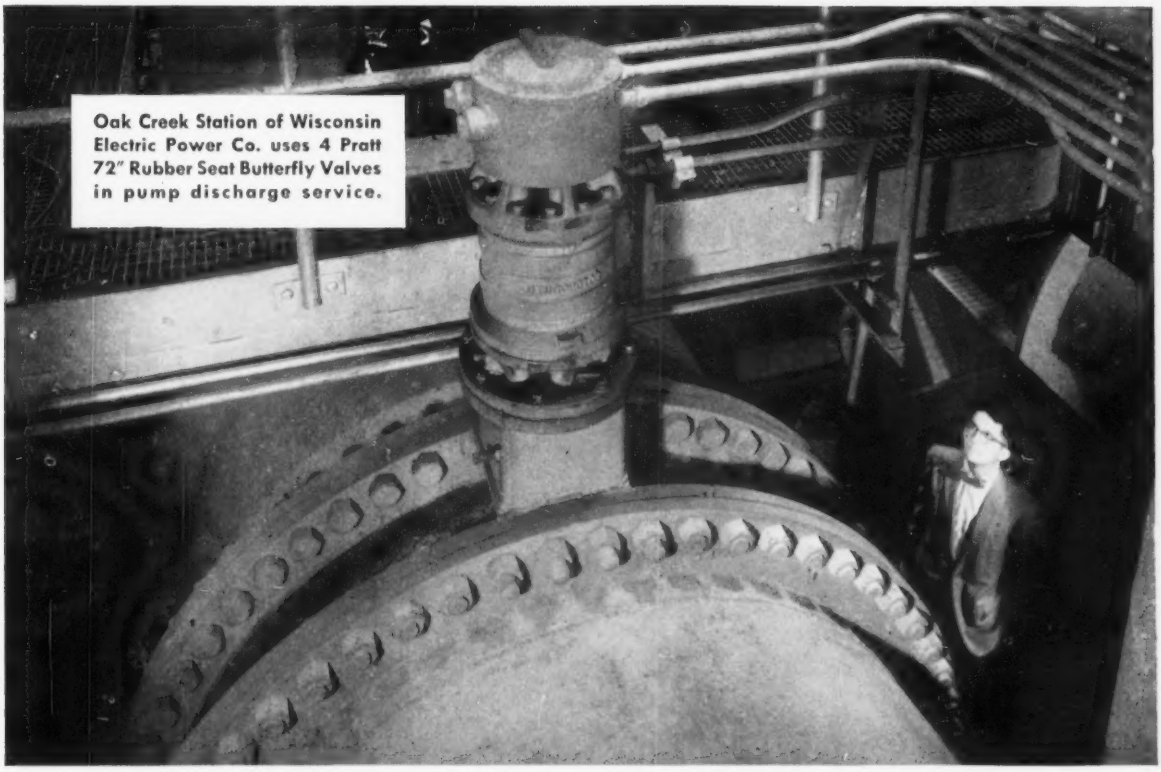
Quick-make, manually charged closing feature and drawout with doors closed provide maximum safety for operator and circuit breaker

You can't tease and burn the contacts of the new quick-make K-Line of circuit breakers—the closing action is fast and positive. An ingenious stored energy mechanism does the job. It stores energy in the first 90% of the pulldown handle travel, releases it in the last 10%. Not until the crossover point is reached do the contacts move. And it closes in only 5 cycles—provides uniform closure every time. *More important, it is the only manually charged stored energy circuit breaker available that will close and latch against its short-time rating.* This means greater safety for the operator, less maintenance, and longer contact life.

You don't have to open the door to move the circuit breaker to test or disconnected position. The crank which operates the simple drawout mechanism fits into the escutcheon through a lift shutter. The shutter cannot be lifted while the breaker is closed. The breaker cannot be closed while the shutter is lifted. This means more than greater safety—you can forget the dirt problem; the nuisance of open doors impeding aisle travel; the risk of circuit breaker damage from exposure, even when completely out of service.

Bulletin 6004-C gives complete information about the new and safer I-T-E K-Line of low voltage switchgear. Contact your nearest I-T-E sales office for a copy. Or write Switchgear Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA



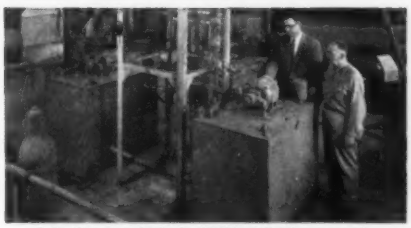
Oak Creek Station of Wisconsin Electric Power Co. uses 4 Pratt 72" Rubber Seat Butterfly Valves in pump discharge service.

MILWAUKEE...Pratt Butterfly Valves offer "two valves in one" for pump discharge

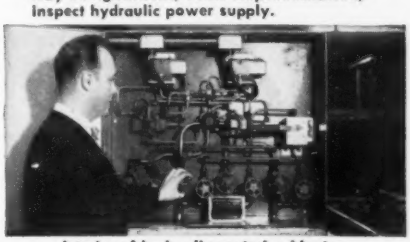
Pratt Rubber Seat Butterfly Valves in pump discharge service can be made to open and close in synchronization with pump operation, AND they close drop tight—combining, in a single valve, the functions normally achieved by separate shutoff and check valves. The simple combination of disc, shaft and efficient closure provides years of dependable performance without maintenance problems.

Pump discharge valves at Oak Creek Power Plant are hydraulically operated with oil motors. The electro-hydraulic system includes a bank of accumulators and complete auxiliary manual controls to permit operation under any emergency condition.

Pratt pioneered the use of rubber seat butterfly valves in power plants, and today offers the greatest aggregate experience on butterfly valving in the power field. For valve design—**with imagination**—see Henry Pratt.



Felix Kazmerchak, Ass't. Plant Engineer, and Ray F. Egebrecht, Pratt Representative, inspect hydraulic power supply.



Interior of hydraulic control cabinet.

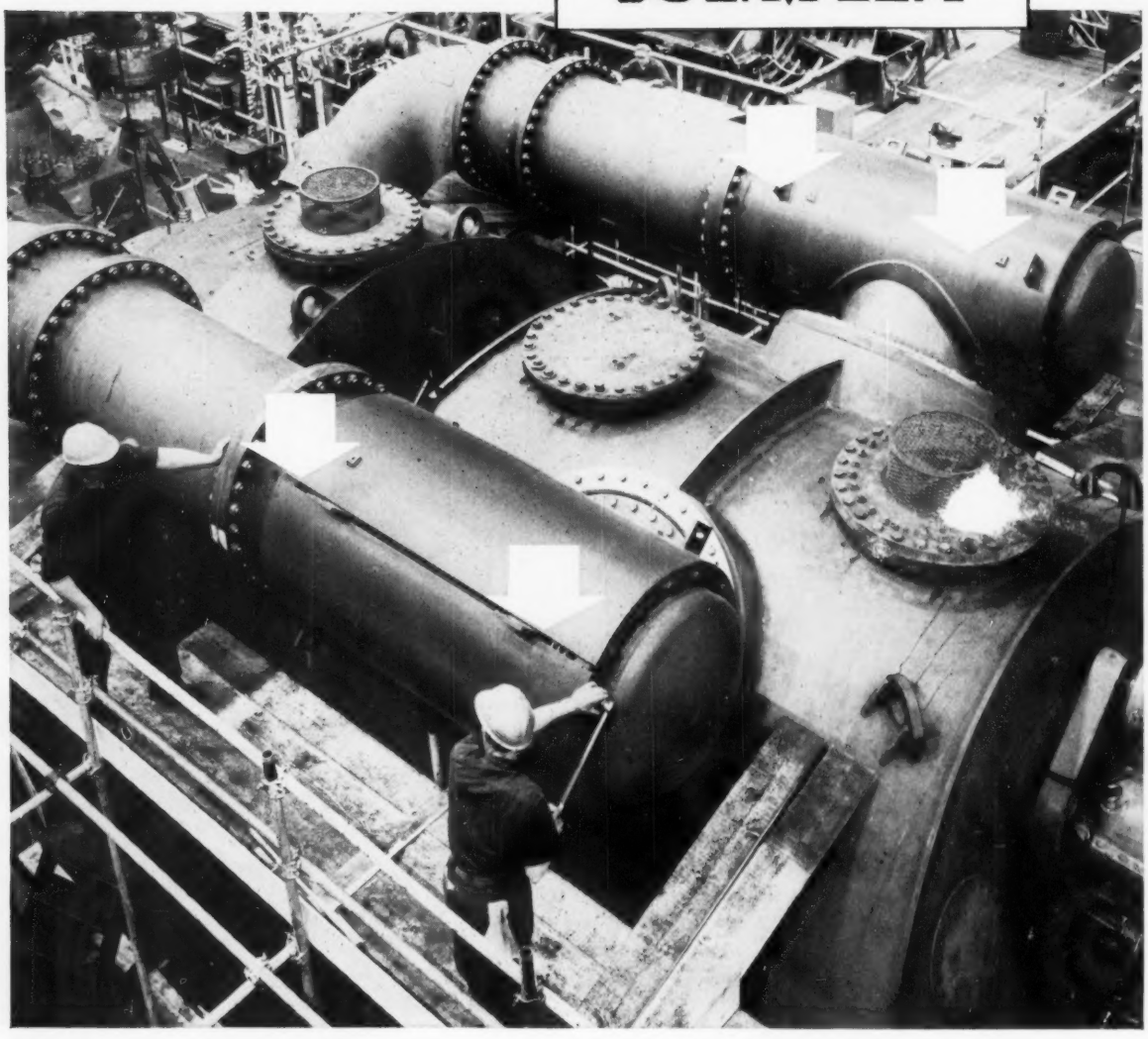
Have you sent for your copy?...of Pratt's 40 page **Manual of Rubber Seat Butterfly Valves.** Useful—contains latest pressure drop and flow data, conversion tables, butterfly valve theory and application. **CATALOG B-2K**

HENRY PRATT

RUBBER SEAT Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

Leading firms use **SOLA-FLEX®**



Sola-Flex joints installed on large steam turbine-generator

TWO 36-INCH SOLA-FLEX expansion joints constrain a pressure thrust of 78,000 pounds on this 225,000-kw General Electric steam turbine-generator. These rugged, pressure balanced elbow joints are an important example of why more and more of America's leading businesses—petro-chemical, power, nuclear and others—rely on Sola-Flex bellows and expansion joints to help solve difficult pressure and temperature problems. Solar manufactures the most comprehensive line of bellows and expansion joints in the world. They are made from a wide variety of stainless and high alloys that are *right* for important nuclear, missile and industrial applications—in sizes ranging from ½ in. to 35 feet in diameter. They are built for service from –320 F to 1200 F, and tame "hard-to-handle" pressures up to 3500 psi for special applications.

A new pamphlet describes Solar's complete line of Sola-Flex bellows and expansion joints. Write for it to Dept. D-168, Solar Aircraft Company, San Diego 12, California.

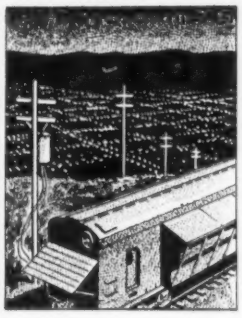
SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS *of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

POWER POINTERS

Rocket hot or Cold as upper air

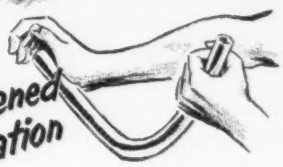
AT THE LOW TEMPERATURES OF HIGH ALTITUDES (BELOW-100°F) ORDINARY STEELS ARE TOO BRITTLE TO USE. AT ROCKET ENGINE TEMPERATURES THEY'RE AS WEAK AS TAFFY. BUT HIGH NICKEL ALLOYS ARE DIFFERENT. INCONEL NICKEL-CHROMIUM ALLOY GETS EVEN STRONGER AND STAYS TOUGH AT SUB-ZERO TEMPERATURES. AND IF YOU TURN ON THE HEAT IT KEEPS USEFUL STRENGTH EVEN UP TO 2000°F.



"Blackout" to "lights on"

...in 12 hours mobile emergency unit delivers 12 times the power of first public utility

12 HOURS AFTER MOVING INTO A DISASTER AREA, THIS GAS TURBINE PLANT ON WHEELS DELIVERS 6,500 KW—OVER 12 TIMES THE POWER OF THOMAS EDISON'S ORIGINAL PEARL STREET STATION. TRANSITION SECTION OF UNIT'S GAS TURBINE, WHICH CHANNELS 1350°F GASES TO BLADES, IS INCONEL* NICKEL-CHROMIUM ALLOY. INCONEL ALLOY RESISTS CORROSION, OXIDATION, LOSS OF STRENGTH AT HIGH TEMPERATURES.



How the tube that couldn't be straightened started instrumentation

TRYING TO STRAIGHTEN A TUBE, INVENTOR BOURDON, CLOSED ONE END AND INJECTED HIGH PRESSURE STEAM. TUBE STRAIGHTENED ...BUT SNAPPED BACK WHEN STEAM WAS GONE! THUS WAS BORN THE BOURDON GAUGE...AND MODERN POWER INSTRUMENTATION. TODAY, MANUFACTURERS MAKE MANY HIGH PRESSURE BOURDON GAUGE TUBES OF "K" MONEL*. THIS NICKEL-COPPER ALLOY IS EASY TO FABRICATE, TAKES PRESSURES UP TO 100,000 PSI, HAS MINIMUM HYSTERESIS.

Having trouble with a metal problem?

TEAMING UP WITH INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU COME UP WITH A PRACTICAL SOLUTION. AS A STARTER, WRITE **DEPARTMENT PE** FOR TECHNICAL BULLETIN "ENGINEERING PROPERTIES OF 'K' MONEL"

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street — New York 5, N. Y.

INCO

*Registered trademark

INCO NICKEL ALLOYS

The Year Advertising Helped

This editorial message was first published by McGraw-Hill two years ago. It describes advertising's dramatic contribution to the American economy during 1954. The theme of the editorial—that advertising can help promote economic stability by stimulating sales at a crucial time—is even more pertinent today.

As our economy grows, it is constantly changing. The conditions business faces today are not the same in every respect as those it faced in 1954. But business again has the opportunity, through advertising and other selling efforts, to help sustain a high level of economic activity. At the same time, it will be building markets for the period of renewed expansion that is sure to follow.

This editorial is reprinted exactly as it appeared in 1956 except for minor editorial changes to bring it up to date. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGraw-Hill Publishing Company, Inc.

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%, and expenditures in all major advertising media rose. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it attained in the years 1955-57.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers had piled up reserves of about $200 billion in cash or its equivalent. These reserves offered a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income. (At the end of 1957, consumer reserves were $225 billion.)

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view is, of course, motivated

McGraw-Hill PUBLISHING COMPANY,

ABP HEADQUARTERS FOR

Kill a Business Recession

by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range investment plans has been the development of sales and advertising programs to reach tomorrow's greatly expanded markets.

Advertising's Key Role

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing over $10 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

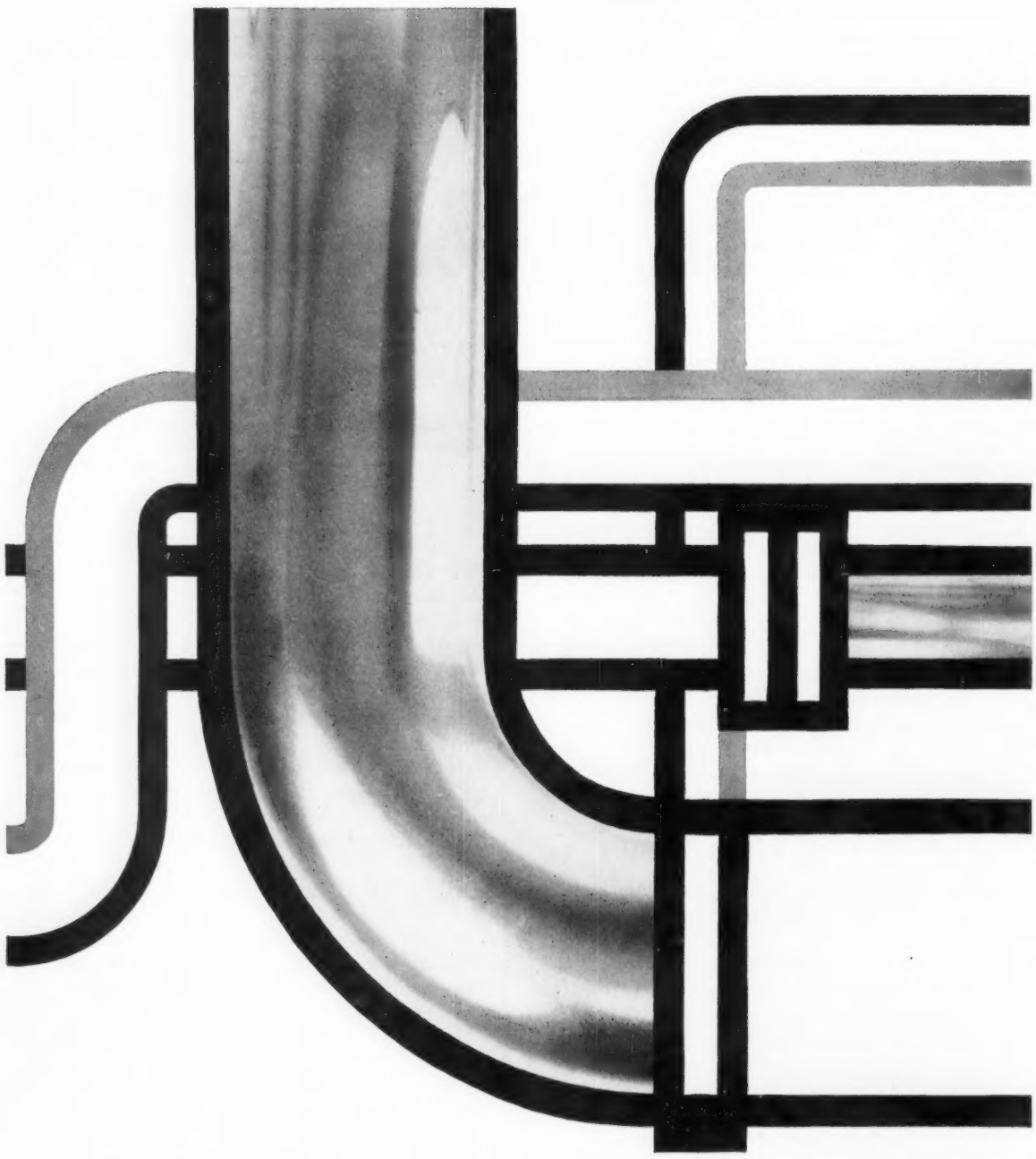
By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself.

One of the surest means of expanding your sales volume in today's industrial markets is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your advertising investment when you *concentrate* in the McGraw-Hill publications serving your most important markets.

INCORPORATED · 330 West 42nd St., New York 36, N. Y.

B U S I N E S S I N F O R M A T I O N



win the fight against corrosion—with Alcoa Aluminum

For over 30 years, Alcoa development engineers have successfully employed the outstanding corrosion resistance of aluminum to solve corrosion problems in the process industries. Their unparalleled knowledge of aluminum's behavior in corrosive situations can furnish proved solutions to your most serious corrosion problems. Let Alcoa show you how to *win the fight against corrosion—with Alcoa® Aluminum.* You'll get these extra benefits, too: Light weight • Good workability Low cost • High thermal and electrical conductivity • Great strength in alloys • Non-sparking characteristics • Non-toxicity • Good reflectivity • Clean, attractive appearance.

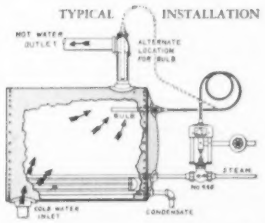
For immediate help, outline your corrosion problems in a letter to ALUMINUM COMPANY OF AMERICA, 888-D Alcoa Building, Pittsburgh 19, Pennsylvania.

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Specify Alcoa Aluminum for
corrosion-free Process Equipment
Pipe & Tube
Tanks, Containers, Trucks & Cars
Plant Structures

If you need to control
tank temperature



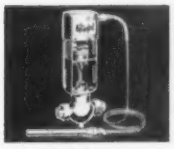
call for a valve from

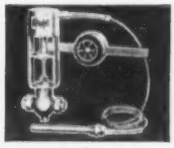
Klipfel

Klipfel Temperature Regulator Valves operate without auxiliary power. Pressure changes in a temperature-sensitive bulb are transmitted to a seamless, 2-ply, extra-strong bellows which opens or closes the valve smoothly to maintain desired temperature.

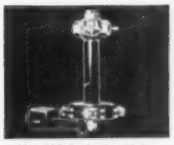
Wide Temperature Range **Indestructible Yoke**
Direct or reverse action **Manual override**
Single, double or three-way bodies

Call your supply house or write for Bulletin 354-A.


No. K-449 Temperature Regulator Valve

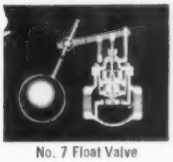

No. K-348 Temperature Regulator Valve

AIR MAIL
Most items shipped within 24 hours after order is received


No. 410 Reducing Valve

No. 300 Reducing Valve

No. 135 Relief Valve


No. 7 Float Valve

No. 27 Float Valve

No. 135 Multiport Relief Valve

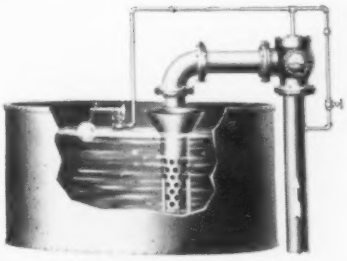
HAMILTON • OHIO Klipfel VALVES INC.

Automatic Temperature-and-Pressure-Regulating Valves Since 1902

Float Valves • Temperature Regulators • Back Pressure Valves • Reducing Valves

A DIVISION OF THE HAMILTON-THOMAS CORPORATION

If you have a
liquid level control problem



call for a valve from

Klipfel

No matter what type of float valve you want, Klipfel has it. And you can get it quickly. Direct Action and Pilot Control, Single and Double Seated Float Valves are all available to give automatic level control of any liquid in large as well as small installations. Valves of special design, and/or corrosion-resistant materials built promptly.

Call your supply house, or write for Bulletin 254.

No. 7 Float Valve

No. 27 Float Valve

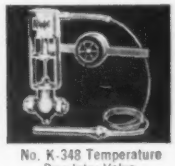
AIR MAIL
Most items shipped within 24 hours after order is received

No. 410 Reducing Valve

No. 300 Reducing Valve

No. 135 Relief Valve

No. K-449 Temperature Regulator Valve


No. K-348 Temperature Regulator Valve

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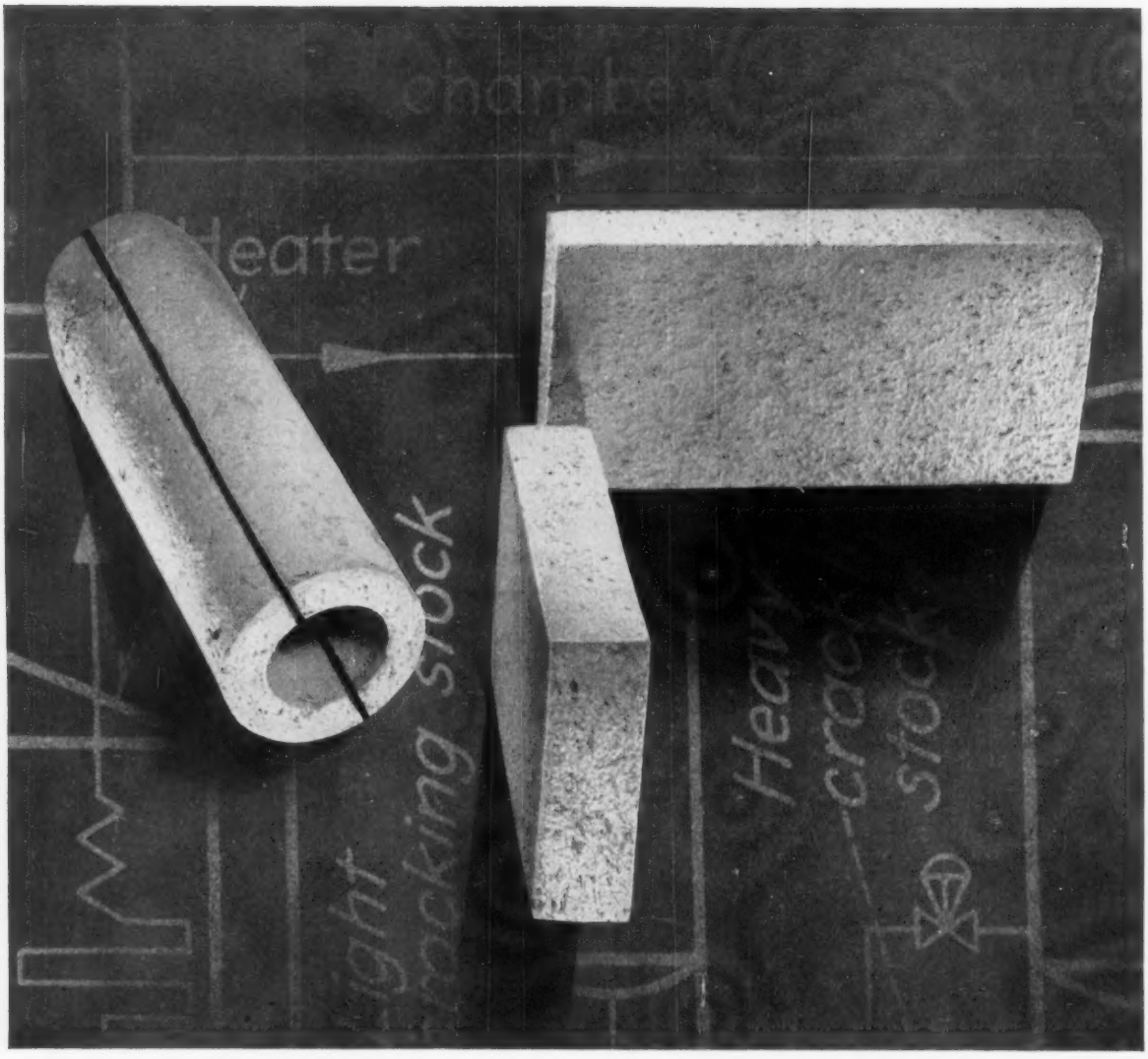

In petroleum refining, as in other process industries, "K&M" Insulations last the life of the equipment.

"K&M" High-Pressure Insulations permit more precise process control!

Permanent and trouble-free, "K&M" High-Pressure Insulations provide peak heating efficiency, lower fuel costs, and tighter heat control year after year. Maintain their insulating efficiency in spite of temperature changes, and other normal operating conditions.

Write to us today for a free brochure which shows how you can cut heating costs.

For temperatures up to 1900°F., use "K&M" Hy-Temp Combination—diatomaceous silica overlaid with "K&M" "Featherweight" 85% Magnesia. Staggered joints prevent heat loss through expansion-caused openings.

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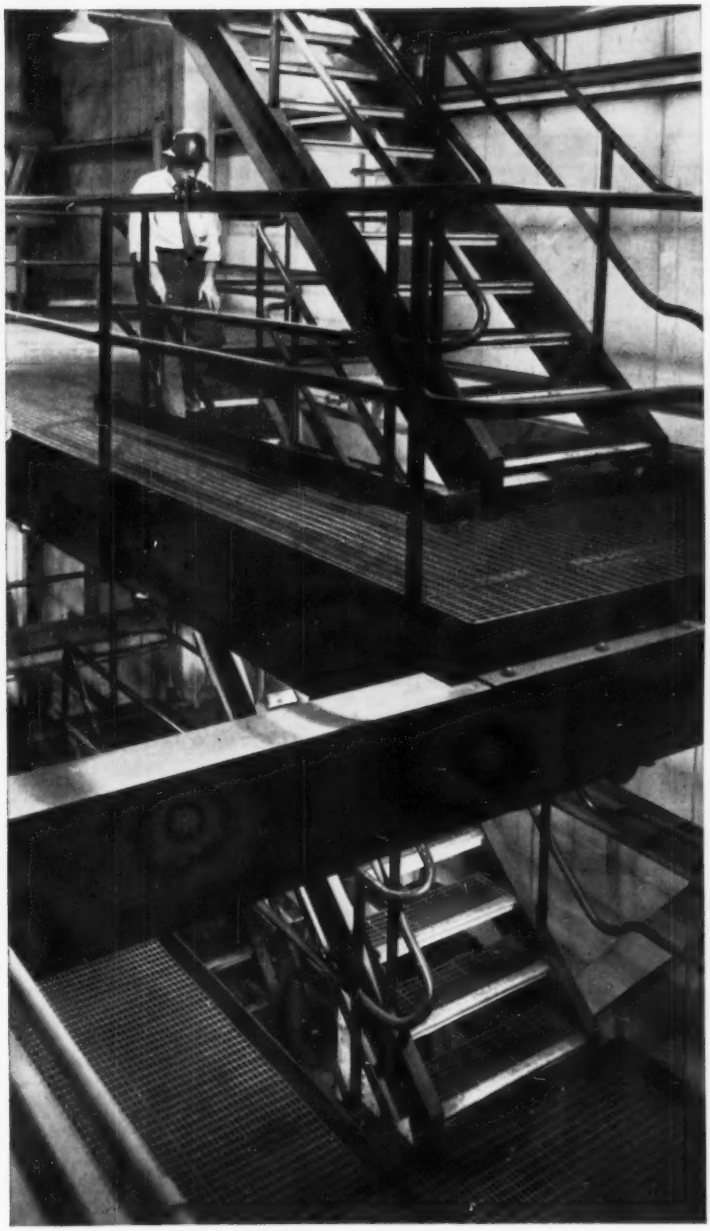
KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

Where a misstep costs $500... Blaw-Knox Electroforged® Steel Grating provides safer non-slip footing



Stair falls cost industry over $60,000,000 a year.

An average accident amounts to a loss of $500 in claims.*

A good way to guard against these profit-eating accidents is to construct your stair treads, walkways and floors with Blaw-Knox Electroforged Steel Grating. Non-slip twisted crossbars and a wide variety of bearing bars are available to meet every kind of working condition—safely solving the most hazardous skid situations.

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Made to your specifications, Blaw-Knox grating provides new highs in safety, easy up-keep and flexible application. For new ideas about grating—including space saving platforms and shelving, write for Bulletin 2486.

*Based on a study analyzing 803 compensable work injury claims closed in Illinois involving stairs and steps.

BLAW-KNOX

BLAW-KNOX COMPANY

Equipment Division
Dept. Y, Pittsburgh 38, Pennsylvania

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MIDCONTINENT TUBE SERVICE INC.
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PAINTING CONTRACTORS
Specialists in
Power Plants, Refineries, Chemical Plants
HARTMAN-WALSH
5078 Easton St. Louis 13, Mo.

This WHERE TO BUY section is a special classification for manufacturers desiring advertising in space units smaller than the minimum run of book display space. Space is available in this section in units from one to four inches. Each advertisement is indexed. For low rates write: Classified Advertising Division.
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EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

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Complete power plants, turbo generators, Boilers, Condensers, Engine generators, Processing Plants and equipment.

PAUL OBERMAN
1910 Delmar St. Louis, Mo.

WANTED

A good used synchronous motor or condenser with a capacity of 500 H.P. or 600 H.P. designed for 80% P.F. with direct connected exciter and with complete starting controls; speed 720 to 900 R.P.M. To operate on 60 cy.—480 V.—3 ph. Must be reasonable in price.

E. L. BRUCE CO.
Box 397—Memphis 1, Tennessee

WANTED:— TRANSFORMER

One 5000 KVA, 57 KV Delta/2,300 volt Delta, 3 phase, 60 cycle, oil filled, air cooled, transformer, with 2-2½% Taps above and below. 7.27% Z. Provision for future fans desirable.

W-7465 POWER
68 Post Street, San Francisco 4, Calif.

WANTED

150-200 H.P. Scotch Boiler
with burner & etc.—Late Model.

AURORA LAUNDRY CO. INC.
562 So. River St., Aurora, Ill.

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publisher to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

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2—200 HP Continental NP716Z—BB—1800 r.p.m. 3/60/220/440
1—30 HP Louis Allis 444—BB—1200 r.p.m. 3/60/220/440

J. L. HEMPHILL & CO.
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Phones
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Head of Mechanical Engineering Dept.—Midwestern University. Developing department in industrial city; new curriculum and laboratories being designed. Industrial salaries matched, opportunity for consulting. Ph.D. or D.Sc. required. P-7539, Power.

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Agents Wanted: To represent old established chimney builder in Detroit, Louisville, Minneapolis, Kansas City and other large cities. Excellent adjunct for an existing boiler accessories representative. RW-7150, Power.

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Power Plant Superintendent, age 36, technical education, 12 years experience in the operation, maintenance and plant betterment of turbo-electric power plants. PW-6856, Power.

Power Plant Engineer—age 30, ex-navy engineer officer and merchant marine 1st engineer, 12 years experience, marine plants. PW-7565, Power.

Power Plant Engineer, age 41, married, technical education, 16 years in field, 2 years assistant shift supervisor in operation large, modern, high pressure steam-electric generating station. Extensive marine operating and maintenance experience. Some refrigeration, air conditioning and diesel experience. Will consider foreign assignment. PW-7533, Power.

Designer-Piping & pressure vessel, all types of welds (ASME & ASTM Codes). Will relocate U.S. or abroad. Able to supervise layouts & field pipe lines including equipment mountings. Can take charge as maintenance engineer on power plants. PW-7591, Power.

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Attention Sales Managers—Well known manufacturers' representative of engineering specialties (steam, water and air) wants to carry your quality line in the New York area. RA-7314, Power.

Graduate mechanical engineer, age 30, wishes to represent manufacturers of valves, couplings, steam turbines, pumps or associated equipment. Six years sales experience. Eastern Pennsylvania, New Jersey, Delaware area. Contacts in petroleum, chemical, paper industries, consulting engineers. Presently employed. Has capital. RA-7542, Power.

Engineer wants accounts for power plant equipment E. Penna. area. RA-7496, Power.

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for your new surplus motors, controls and transformers!
AVAILABLE: NEW MOTORS
Write, wire or phone collect!
AJAX ELECTRIC MOTOR CORP.

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Excellent opportunity for graduate engineer in operations and maintenance of industrial power and steam department supplying chemical plant.

Will start as operating assistant. Operation and maintenance of utility distribution systems included.

Previous experience, 3-5 yrs. desired.

Submit resume to Industrial Relations Department.

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MECHANICAL ENGINEERS

Steam-Electric Power Plants

Established Engineering-Construction firm with offices in Chicago and New York needs Engineers experienced in directing mechanical design groups. Must be graduate. Experience in heat balances, general design calculation, specification writing and overall engineering and drafting coordination. Age 28-40. Position in Chicago office. Submit resume to

P-7585 POWER
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Complete stock from 10-2,000 h.p.
Nation's largest inventory, New & Used

WABASH POWER EQUIPMENT CO.
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G.E. GENERATING PLANT

31.3 VA, 3 phase, 60 cycle, 208/120 volts. Model 12G130. Direct connected to Lerol engine 4 cylinder gasoline driven #163310. Boxed for export 5910 lbs. 241 cubic feet includes $100 worth of spare parts. Price $1850.

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W. R. KEATING & CO., INC.
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78' high 20 ton per hour, bucket elevator complete with track hopper and 24' flight feeder. Used only 6 years, and is in excellent condition. Can be purchased for less than half its original cost of $15,500.

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Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
700	Whse.	Slipring	2300/4000	1200
500	G.E.	Slipring	2200/440	600
500	Whse.	Slipring	2200	450
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	El.Machy (2)	Synch.	2200/440	720
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Synch.	440	1200
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	L.A. TEFC	Sq. Cage	440	1200
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
175	G.E. (2)	Synch.	220/440	720
150	Rel. TEFC	Sq. Cage	220/440	900
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slipring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800
75	G.E. b.b. (6)	Sq. Cage	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	G.E. b.b.	CD	250	1800
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
125	Gen. Elec.	CD	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
25	Whse.	SK-103	250	1750
20	Ideal	D-405	125	1150

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	G.E. b.b.	CY-290	230	1750
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
150	Whse.	SK-210	230	320/1000
125	G.E.	CD-178	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	Gen. Elec.	CD-95	230	1800
50	G.E.	CD-125	230	400/1200
50	G.E.	BF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	G.E.	CD-113	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	G.E.	2200/440 AC	600 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.*(2)	220/440 AC	250 DC
75	Gen. Elec.	220/440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	250 DC

Arthur Wagner Co.

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MO nroe 6-7409

1435 W. RANDOLPH ST

CHICAGO 7, ILLINOIS

FOR SALE

STEAM BOILERS

2—18000 lbs./Hr. Heine 175 psi, straight tube, oil fired, 1920

3—21000 lbs./Hr. Combustion Engr. 200 psi, Stoker fired, 1938

1—35000 lbs./Hr. Combustion Engr. 450 psi, 825° stoker fired, 1950

SURFACE CONDENSER

1—2500 Sq. Ft Westinghouse, 2 Pass, with aux., 1950

DIRECT CURRENT GENERATORS

1—100 KW, General Electric, 250V, 1200 RPM, 1950

1—250 KW, Westinghouse, 250V, 720 RPM, 1950

MOTOR GENERATOR SET

1—25 KW, Westinghouse, 250V DC, 208/120V AC, 1800 RPM, 1950

WATER PUMPS

1—14000 GPM @, 370' Hd. De Laval Centrifugal, 690 RPM, 1800 HP, 1920

1—20800 GPM, @, 370' Hd. De Laval Centrifugal, 720 RPM, 2500 HP, 1949

1—24500 GPM @, 370' Hd. Worthington Centrifugal, 950 RPM, 3200 HP, 1954

STEAM TURBINES

1—1800 HP, De Laval Condensing, 165 lbs. psi 3600/690 RPM, 1920

1—2500 HP, De Laval Condensing, 400 lbs. psi 3600/720 RPM, 1949

1—3200 HP, Worthington Condensing, 175 lbs. psi 3600/950 RPM, 1954

INTERNATIONAL POWER MACHINERY CO.
1612 Union Commerce Bldg.
Cleveland 14, Ohio **Main 1-9514**

FOR SALE—EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
Frequency Changers—Transformers—Pumps, Boilers.

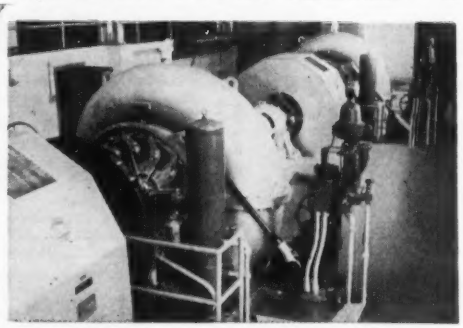
UTILITIES MACHINERY CORPORATION
1965 East Sixth St., Cleveland 14, Ohio • PHONES: CHerry 1-0210 & CH 1-4070

TRANSFORMERS

3—833 KVA, 1/60/34500-460 Moloney OISC with taps
2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
1—225 KVA 3/60/440-208Y/120, Moloney Dry type.
5—10 KVA, 1/60/240-480/120-240 Sorgel Dry type

CASH
For Surplus Electrical Equipment
BENSON-WILIMZIG, INC.
1708 North 8th St., St. Louis 6, Mo.
Phone GArfield 1-4290

TWO 1,500 KW HYDRO ELECTRIC PLANTS



2000 HP Pelton type Turbines, 160 ft. head, 600 RPM, 4160 Volt, 3 phase, 60 Cycles, .8 PF, Direct connected excitors, complete modern cubicle. Three 1250 KVA Transformers 66,000-38,150-4160 Volt, and taps. Plants were in service less than four years and are in new condition. Immediate delivery.

GENERAL MACHINERY LIMITED
GRANVILLE ISLAND **VANCOUVER, B. C.**

FOR SALE
15 NEW TURBINES

4 horizontal, 11 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

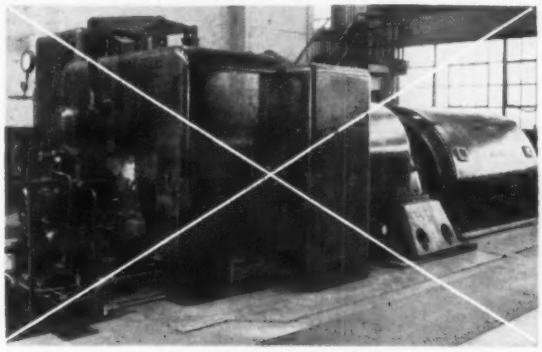
Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. De ROSE
2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

EXCLUSIVE OFFERING!

650 lb., 725 DEG. TURBO-GENERATORS — Just Purchased as Released from Service — Available Now — Very Modern — 7500 KW, 80% PF, Westinghouse Unit



Sold
See unit same rating below.

ACTUAL RECENT PHOTOGRAPH

Above exceptionally fine unit placed in service in 1949 and constantly maintained in excellent condition. Turbine designed for 650 P.S.I.G., 725° F.T.T., automatic extraction at 125 P.S.I.G., Westinghouse Generator 9375 KVA, 7500 KW, 6900 volt, 3 phase, 60 cycle, 3600 RPM, with dir. conn. 125 volt exciter. Complete with surface condenser, switchboard, voltage regulator and operating auxiliaries.

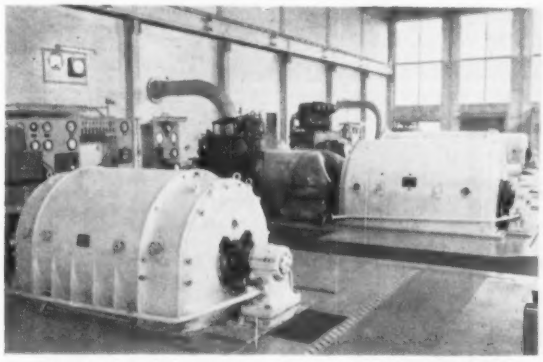


PHOTO OF OTHER AVAILABLE WHSE. TURBO-GENERATORS

These additional units in other power plant — same location — here locally where recently discontinued from service. All designed for 650 P.S.I.G., 725° F.T.T., Westinghouse Generators 6600/6900 volt, 3 phase, 60 cycle, 3600 RPM.

1—9375 KVA, 7500 KW, 125 P.S.I.G. auto extraction, surface condenser, installed in 1937.

1—9375 KVA, 7500 KW, non-condensing, 125# B.P., installed 1930.

1—6250 KVA, 5000 KW, Condensing, with surface condenser, installed 1942.

~~1—5000 KVA, 4000 KW, non-condensing, 125# B.P., installed 1927.~~

~~1—5000 KVA, 4000 KW, 380 P.S.I.G., non-condensing, 125# B.P., installed 1930.~~

All units complete with operating auxiliaries.

Can be inspected where installed — Bargain Prices.

•

BELYEA CO. INC.

43 HOWELL STREET **JERSEY CITY 6, N. J.**

N. J. Phone: OLdfield 3-3334
N. Y. City Phone: REctor 2-7150

Industry Approved . . .

ELECTRIC POWER EQUIPMENT

REBUILT BY CHICAGO ELECTRIC

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	*G.E.	M-575-S	1200
1000	*West.	CW	450
600	*G.E.	M-6345-B	1800
500	G.E.	M-6345	1200
400	*G.E.	MTP-565	1200
350	*Al-Ch	ARYW	1800
300	Cr-Wh	SR70-R	1800
250	Al-Ch	ARY-626	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
150	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	600
125	G.E.	I-M-15A	600
100	G.E.	I-E-13A	1800
100	G.E.	MT558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200
75	G.E.	MT-347	1200
75	G.E.	MT-356	900
75	G.E.	MT-352	720
75	G.E.	I-M-10	600
60	G.E.	MT-536	1200
60	*West.	CW-762C	900
50	*G.E.	MT-536	1200
50	Al-Ch	ARY-223	900
50	West.	CW-753	720
50	Al-Ch	ANY-26	600
40	G.E.	MT-532	1200
40	G.E.	MT-336	900

HUNDREDS OF SLIP RINGS OF SMALL SIZES — ALL SPEEDS

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

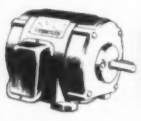
H.P.	MAKE	TYPE	SPEED
1750	*G.E.	K	3600
1750	*G.E.	K	1800
1250	*Al.-Ch.	ANX	3600
600	West.	CS	720
600	*G.E.	K-63455	1200
500	*G.E.	K-63455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-559-A	1800
300	*G.E.	K6344	1200
250	*W (TE)	CS-81205	1800
250	*G.E.	KT-599-S	1800
250	*West.	CS-875-S	1800
250	Brook	RS28	1200
200	*G.E.	FT-540	3600
200	West.	I-K-13B	1800
200	Brook	CSP-581-S	1800
200	*West.	RS-27	1200
200	G.E.	CS-930-A	900
200	*Al-Ch	KT-564-S	720
200	*West.	AN-37-G	720
200	Al-Ch	CS-1010	600
200	*G.E.	ARW-631	600
150	Cr-Wh	SC-140	3600
150	Al-Ch	AN-30-F	1200
150	West.	CSP-5815	1200
150	G.E.	I-K-15A	900
150	*West.	CS	600
125	Al-Ch	AR-226	1800
125	Cr-Wh	5-Q	1200
125	G.E.	K-558	900
100	W (TE)	CS-507-S	3600
100	G.E.	FT-542-Z	1800
100	Al-Ch (TE)	ARZ-826	1200
100	Al-Ch	AW-23-D	1200

YOU GET THESE ADVANTAGES!

1. **50% to 80% COST SAVINGS!** You can have the particular equipment your want at a tremendous savings!
2. **NEW EQUIPMENT PERFORMANCE!** Fully reconditioned to perform as per nameplate specifications—AS GOOD AS NEW!
3. **FULLY GUARANTEED!** Your complete satisfaction fully guaranteed on all equipment and every transaction!
4. **LIBERAL TRADE-IN'S!** Tremendous inventory necessitates extensive buying—we must trade higher!

SPECIAL
NEW WESTINGHOUSE
Single Step, Primary resistance magnetic Squirrel Cage Motor Starters. 3/60/—Class 11-400

Phone CAnal 6-2900



CHICAGO Electric Co.

1320 WEST CERMAK ROAD • CHICAGO 8, ILLINOIS

6—800 HP B&W Water Tube Boilers. 200# steel Headers. No superheat.
6—600 HP B&W Water Tube Boilers. 225# steel Headers.
2—300 HP B&W Sectional Headers long Drum Boilers steel Headers 200# WP.
1—300 HP Cleaver-Brooks, 1954. Full Auto #6 Oil, N. J.
3—599 HP Springfield Sect. Hdr. Cross Drum. 1926. 250# WP Superheater. N. Y.
1—60,000#/hr. B&W FF. 1947. 250# WP. Complete pumps, fans, oil burner, oil burner pump set and control panel.
1—Permutit Water Softener. 100 GPM Capacity. Zeocarb.
1—Coffin Turbine Driven Feed Pump. 200 GPM 650 lbs. Discharge Pressure Type "G" Pump. 225# Initial Pressure 10# B. Press.
3—Turbine Driven I.D. Fans. Cleveland Reduction Gears. Size 400. ATW Ratio 7-1. Lee Turbine 40 HP @ 3465 RPM. Fan Capacity 47,000 CFM. Will sell Reduction Gear independently.
1—30,000 Swarthout Deaerator with Controls & 5000 gal. Storage Tank. Fla.
2—Induced Draft Fans. Dual Turbine & Motor Drive. 20,000 CFM. Fla.

SHERB PLANT CONSTRUCTORS
342 Madison Ave., New York 17, N. Y.
Telephone: MUrray Hill 2-9098

BARGAIN OPPORTUNITY

600 HP—720 RPM, General Motors Model 567 Electro Motive Diesel engine direct connected to a:

500 KVA—400 KW at 80% PF, 720 RPM, 3 phase 60 cycle, 480 volt Westinghouse alternating current generator.

Complete installation. Equivalent to new.

EUCLID ENGINEERING CORP.
609 National City E. Sixth Building
Cleveland 14, Ohio

---

2 OIL BURNING BABCOCK & WILCOX WATER TUBE BOILERS

Designed for T2-SE-A2

Now being removed at Philadelphia, Pa., from the S.S. Mission San Francisco.

Complete with deaerating feed heaters, Coffin feed pumps, oil pumps, 1st, 2nd & 3rd stage heaters. Evaporation: normal 43,000 lbs.; max. 60,000 lbs. Designed boiler pressure 700 P.S.I. Final steam temp. at superheater outlet 825° normal. Superheat safety valve setting 624 P.S.I. Boiler heating surface including water wall 6350 sq. ft. Total water heating surface 8030 sq. ft. Economizer heating surface 1680 sq. ft. Operating pressure superheater outlet 600 P.S.I. Furnace volume 573 cu ft. Evaporation rate from and at 212 F lbs/hr/sq ft of total boiler heating surface: Normal 8.33—max. 11.74. Water wall heating surface 118 sq ft. Feed water temp 240 F. Immediate delivery. Presently on barge at Philadelphia. Dimensions: 19'8" high over drum flange: 14' 9-5/16" over casing plate; 16' wide over drum.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

OPPORTUNITIES!

in

New and used equipment recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
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Send for new list . . . to

EBASCO SERVICES INCORPORATED
APPARATUS EXCHANGE
Two Rector St., New York 6, N. Y.

FOR SALE

Steam mixed pressure bleeder turbine with condenser; Terry turbine type GZF8 1949 rated 800 HP at 4100 RPM with 140#-30#-20" vacuum. Worthington surface condenser for above turbine 1010 square feet in Admirality tubes, over all size 39½" x 14'2".

Turbine driven York VW Ammonia Compressors consisting of 400 HP DeLaval steam turbine type MCA and DeLaval direct connected gear reducing unit on common bed plate, 4540/720 RPM with rubber shear couplings driving two York 6¾ x 5 eight cylinder ammonia compressors, complete with Ammonia oil separators and oil return traps, plus, ample spare parts and panel board with automatic air controlled system. Original installation June 1951. Compressors rated 250 tons ammonia. Over all floor space 7½' x 20'.

Can be seen in place at:

P. BALLANTINE & SONS
57 Freeman Street, Newark 1, N. J.

2-600 HP Cooper-Bessemer Diesels/Gas
50 HP Kewanee Firebox Boiler 100# P.
250/312/375 KVA Skinner Unaflow Sets
5/2030 Ton OET Cranes—complete
30/80/125/400 HP Package Boilers
426 HP B&W 3-drum WT Boiler
72"x20' 150# Pressure HRT Boiler
24"x24" Jeffrey Single Roll Crusher
H. & P., 6719 Etzel, St. Louis 14, Mo.

DIESEL ENGINES — POWER MACHINERY

100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

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MAIN OFFICE: Box 516, Sausalito, Calif. Sausalito 1600 **BRANCH: 50 Church St., N. Y. 7, N. Y. Digby 9-4350**

AUTOMATIC and MANUAL
GAS Or DIESEL GENERATOR UNITS
Complete Switchboard Design or Construction
USED & REBUILT EQUIPMENT
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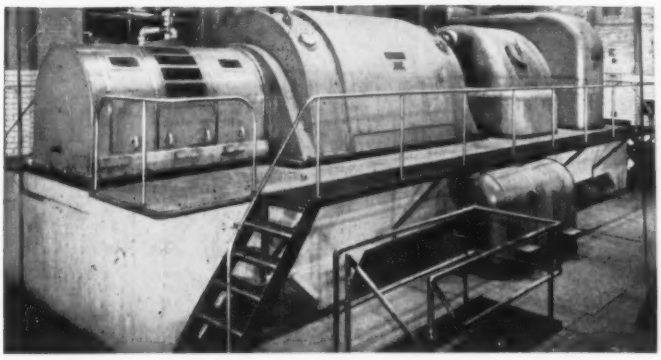
217 Colden St. Jersey City, N. J.
Phone: DElaware 2-8300

IMMEDIATELY AVAILABLE

650 LB. PRESSURE, 750° FTT TURBINE-GENERATORS

10,000 KW, 70% P.F., 14,286 KVA below:



This 10,000 KW is a Westinghouse, Condensing 650 Lb. PSIG, 750° FTT Turbine. It is equipped with Surface Condenser, Switchboard, with all auxiliaries, direct connected Exciter (closed type). Generator is 3/60/12000 V., 3600 RPM at 70% P.F., 14,286 KVA. Installed new in 1947.

CHARLES WEAVER, INC.

19701 James Couzens Hwy. **Tel: BRoadway 3-1900** **Detroit 35, Michigan**

TRANSFORMERS

2—2000 Kva GE 13200-2400 Scott Tap
7—1667 Kva GE 13800-600
3—1000 Kva GE 13800-460
15— 50 Kva GE 33000-2400 New
120— 25 Kva GE 33000-2400 New

MOTORS • GENERATORS
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AMERICAN ELECTRIC SERVICE & MAINTENANCE CO.
Paramount & 2nd Sts., Springfield, Mass.
REpublic 2-2104; 2-2105

POWER PLANT EQUIPMENT

SPECIAL OFFERINGS

TURBO-GENERATORS

1—3000 KW — 13,200 V — N. C. 425# — 170 Ext.—50# BP
1—3000 KW—4150 V 350# Cond.
2—2000 KW—6600 V—N. C. 625#—155# BP
1—1000 KW—240/480 V—Cond. 130/250#—Ext. #15
2—750 KW—250 V—DC—N. C. 250#—25# BP
1—300 KW—480 V—Cond. 210#—Ext. 40#
1—250 KW—240/480 V — N. C. 130# — 10/15# BP

DIESEL LOCO. CRANE

1—25 Ton—50 Ft. Boom.

A. LEE ELLIS CO., U.S. Machy. Bldg., 140 Federal St., Boston 10, Mass.
THE BUYERS MUST BE SATISFIED—ALWAYS

COMPRESSORS

1902-1958

WORLD'S BEST REBUILTS

100 CFM 125 psi 6x7 Ing. or Worth.
138 CFM 100 psi 7x7 Ing. ES-1
140 CFM 3500 psi 12½x10 Norwalk—unused.
191 CFM 350 psi 9-4x9 Ing. ES-2
238 CFM 100 psi 9x9 Eng. ES
288 CFM 500 psi 10-4½x10 Ing. or Worth.
420 CFM 40 psi 12x9 Ing. oil-less (new cylinder)
465 CFM 100 psi 12x11 Penn. or Ing.
502 CFM 125 psi 12x13 Worth. HB.
585 CFM 100 psi 15-9¼x12 Ing. XRE 3-60-4160
590 CFM 100 psi 13½-8x8 Penn DE2 3-60-220
676 CFM 100 psi 15-9¼x12 Ing. XRB—Worth.
686 CFM 100 psi 14x13 Worth. HB.
790 CFM 100 psi 15½x9½x10 Ing. XRE 3-60-4800
800 CFM 125 psi 14½-9x7 Ing. XLE 3-60-440
870 CFM 125 psi 17-10½x12 Ing. XRE 3-60-220-
1007 CFM 100 psi 19-11x12 Chic. OCB
1240 CFM 125 psi 19½-12x10 Ing. XVH 3-60-2300
1410 CFM 35 psi 20x13 Worth. HB—unused.
1721 CFM 125 psi 23-13x18 Chic. OCE 3-60-2300
2832 CFM Vacuum 31x13 Ing. St. or Elec.
PORTABLES—55-60 CFM Rotary or Reciprocating

American
AIR COMPRESSOR CORP.
DELL AVE. & 47th ST.
NORTH BERGEN, N.J.
Telephone UNion 5-4848

HIGH PRESSURE STEAM BOILERS

***Government Surplus* SAVE OVER 75%**

NEW, NEVER USED, NEVER ERECTED, AVAILABLE IMMEDIATELY

121,650 Lbs.

1 Foster Wheeler

Express Type, 3-drum, with integral superheater separately fired.

Includes boiler, superheater, economizer, 7 fuel oil burners, soot blowers.

Pressure 634 psi, temp 850° F.

Furnace Vol: boiler 310 cu. ft., superh. 247 cu. ft.

60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler

"D" Type, 2-drum, with integral superheater fired between boiler tube bank.

Includes boiler, superheater, economizer, 3 fuel oil burners, soot blowers.

Pressure 435 psi, temp 750°F.

Furnace Vol: 330 Cu. Ft.

We own and stock these boilers. Inspection Invited at Utica, N.Y. Subject to prior sales.

PELNIK-LOCONTI INDUSTRIAL SUPPLY CO.

Office Ph. Utica 6-4621 • 315 Oriskany St., Yorkville, N.Y. • Yard Ph. Utica 2-4513

ELECTRICAL POWER EQUIPMENT

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. RB	SP806S	4800/2400	1800
1	800	Whse.	CW	550	1776
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1778
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-718SR	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1039C C-15	440	720
1	250	G.E.	MT-424Y	4000	257
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
2	450	Whse.	CS-1420	2300/4150	354
2	100	Whse.	CS-7151-610H		
1	300	Elliott		6600/4000	3565
1	125	Allis Ch.	BA-684Z	440	1770
1	400	G.E.	AW-23FS	440	1170
2	200	G.E.	IK	2200	500
2	200/150	Whse.	KT-557	440	1800
1	200	Whse.	CS-963H	2300	1175/878
1	150	Whse.	CS-1002	2300/400	450
1	150	G.E.	CS IK-15A	440 2300	580 860

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
1	3500	G.E.	TS-6487P	4600/2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	660	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	600	600	2300/4150
1	1000	G.E.	900	260	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El Mhy	1200	250	2300/4600
1	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/3300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	7500	Whse.	650# condensing, 125# auto extraction, 6900 V.
1	5000	G.E.	400# surface condenser 2400/4150 volts.
1	4000	G.E.	400# surface condsenser 2400/4150 volts.

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
1	1500	G.E.	PYRANOL	3 auto	4000/4200/4400
3	1000	G.E.	OISC	1	12800x460
2	750	G.E.	FUR	1	4800x35/55
3	500	KUHL	OISC	1	13600x6000
1	225	Marcus	Air	3 auto	208/220
2	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
3	6750	G.E.	60/25/60	13200/13200
1	5000	G.E.	60/50/60	11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

COMBINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—2250 HP Elliott 300 V. 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V. 450 RPM 3 ph. 60 cy.

1—1375 H.P. G.E., MCF, 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V DC, 2300/4000 V. 720 RPM 3 ph. 60 cycle.

1—1200 HP G.E. MPC, 600 V, D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

RE-NU-BILT BY

BELYEA COMPANY INC.
43 Howell St., Jersey City 6, N. J.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
350	4000/2300	G.E.	720
300	2200	G.E.	450
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2300/440	G.E.	720
150	220/440	Whse.	720
125	2300	G.E.	600
100	440/220	G.E.	720

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2300/440	G.E.	TS	1200
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
500	2200/4000	Elliott	SC	1800
350	2300/440	G.E.	IE-K	1200
300(2)	2200	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440/220	G.E.	KT	720
200	440/220	G.E.	KT	1800
200	2300	G.E.	KT	1800
200	440/220	G.E.	KT	720
200	2200/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	720
125	2200/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200
75	2300/440	Whse.	TEFC	1200

A. C. GENERATORS

1—320 kva, 660 rpm, 2300/440/220 V., G.E.
1—360 kva, 900 rpm, 2200 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

9—1600 amp ITE, 3 pols, 600 V.
6—FKB-155-28, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit. 3P, 25 KV outdoor
1—400 Amp. R. Smith, 3 P 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	1800
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	850

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph
3—600 kva, G.E., 13,800—360 V.
3—333 kva, G.E., 13,800—2300 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—150 kva, Al. Ch. 2400—220 V.
3—150 kva, Al. Ch. 440-230 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, G.E., 2400—120/240 V., Pyr.
6— 50 kva, G.E., 13800—120/240 V.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

BARGAINS NEW CONDENSER

11000 SQ. FT. UNITS

3 New Worthington Surface Condensers—11000 sq. ft each—single pass—Monel water boxes—Cupro-Nickel tubes & tube sheets. Tubes ⅝" O D CAPACITY lbs/hr—70,000; circulating water 14180; circulating water connections 30"; operating weight 86,000 lbs; overall length approx 21'- width & height 9'4" Built for U.S. Navy. Designed for low head room.

8900 SQ. FT. UNITS

1 New unit by C. H. Wheeler. Test pressure: shell 30 lbs; water box 30 lbs.—single pass. Turbine steam exhaust inlet 6' 1¾" x 10' 2". Overall width 12' 2¼"; overall length 14' 10¾"; overall height 5'7". Water inlet 36" x 30" outlet. Monel heads and water boxes; Cupro-Nickel tubes. Built for U.S. Navy of very best materials.

1135 SQ. FT. UNITS

2 New Units by C. H. Wheeler. 2-pass—shell 30 PSI—tubes, chest 30 PSI: DIMENSIONS: 42" diam.—12' long. 24" exhaust steam inlet —water box inlet & outlet 10". 9300 lbs./hr. steam capacity; 1175 GPM circulating water. Complete with twin air ejectors type 4H Wheeler with inner cooler. Built originally for Navy.

580 SQ. FT. UNITS

6 New units—Capacity: 4300 lbs/hr on 28.5 vacuum. 8" water inlet & outlet—18" steam inlet. 2 pass— complete with air ejectors.

3 LIBERTY SHIP TYPE UNITS

2700 Sq. Ft.—2-pass type.

OTHER SIZES IN STOCK FOR IMMEDIATE DELIVERY

NEW CIRCULATING PUMPS

1 only—vertical circulating pump—all-bronze propeller type—geared turbo driven—840 RPM —26500 GPM at 25' head. W.P. turbine, Westinghouse, 575 lbs—0°F superheat. Pump—Warren type 25 VP.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

FOR SALE

HIGH PRESSURE BOILER

35,000 pound steam per hour Combustion Engineering boiler, type VU, two drum, bent tube, 450# steam pressure, 825° FTT, complete with spreader stoker and automatic control.

New 1950—Excellent Condition

INTERNATIONAL POWER MACHINERY COMPANY
1612 Union Commerce Building
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COMPLETE DIESEL PLANT

2—Fairbanks Morse 450 HP Model 32E14 375 KVA. 3/60/2400 volts. With complete auxiliaries. New in 1944.

1—Fairbanks Morse 360 HP Style VA, 257 RPM 300 KVA. 3/60/2400 volts. With auxiliaries.

These units can be purchased individually at a real bargain price. Condition is first-class.

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FOR SALE

NEW BOILERS

153,600#/Hr. 565 P.S.I. @ 850°F.
122,500#/Hr. 565 P.S.I. @ 850°F.
60,000#/Hr. 435 P.S.I. @ 750°F.
35,000#/Hr. 285 P.S.I. @ 577°F.

Complete units including superheaters, economizers, fuel oil burners, soot blowers, valves and fittings.

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MODERN TURBO POWER PLANTS

1875 KVA 400 P.S.I., 2300 V with 25,000#/Hr. Boiler 450 P.S.I.
2500 KVA 600 P.S.I., Extraction 160 P.S.I. 75,000#/Hr. Boiler

13750 KVA Power Plant consisting of (11) 1250 KVA Rathbun-Jones Natural Gas Engine Generators. 3/60/2300-4160V, Panel.

OTHER DESIRABLE ITEMS

720 KW MG Set 120/180 2300 V Synchronous Drive with Panel
540 KW Turbo Generator DC 120/240 V
500 KW MG Set 125-4100V
1000 Amp. MG Set 170/40-4400 V
2000 Amp. MG Set 80 V 25 Cycle
2000 KVA Furnace Transformer 13200/120 V (3)
300 KVA Inerteen Transformer 3 ph, 2400/480
175 HP 275 P.S.I. C.E. Package Boilers
7900 CFM 110 P.S.I. C.P. Compressor OCE

HEAT & POWER Co., Inc.

POWER EQUIPMENT DIVISION

40 EAST 42nd ST.
NEW YORK 17, N.Y.
MUrray Hill 7-5280

310 THOMPSON BLDG.
TULSA 3, OKLAHOMA
Diamond 3-4890

BOILERS

B&W, 55,000#/Hr., 650#, 750 Deg. F. New 1953
B&W, 55,000#/Hr., 650#, 750 Deg. F. New 1942
B&W, 45,000#/Hr., 450#, 750 Deg. F. New 1951
B&W, 27,000#/Hr., 450#, 750 Deg. F. New 1948

TURBO-GENERATORS

1—1500 KW, West. 400 psig. 3/60/2400/4150—1948
1—1500 KW, G.E., 240 psig. 3/60/2300—1922
1—1000 KW, West. 160 psig. 3/60/2300—1929
1—1000 KW, West. 400 psig. 3/60/2400—1930
1—300 KW, Elliott. 425 psig. 3/60/2400/4160—1940

POWER TRANSFORMERS

3—G.E. 1/60/43800/7586OY—13900 V, 16,667 KVA each.

DIESEL-GENERATOR EQUIP.

1—Fairbanks-Morse 700 KVA, 2400 V, 257 RPM—Oil.
1—Rathbun-Jones, 1250 KW, 2400 V, 240 RPM—Gas.

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SIX DETROIT ROTO SPREADERS

Fronts and Dumping Grates. Now installed on three B&W Type F. F.—16-28 Boilers. Excellent condition. Now in operation. Will be removed this summer and replaced with continuous cleaning type stokers.

FS-7469, POWER

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SQUIRREL CAGE MOTORS NEW AND GUARANTEED REBUILT

HP	Make	Type	Speed
400	West. B.B. Drip.	CSP-681S	1800
400	West. S.B. Open	CS	900
350	A.C. S.S. Drip	ARWW-626	3600
300	G.E. S.B. Open	IK	1800
300	A.C. S.B. Open	AR-630	1800
300	F.M. S.B. Open	H	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open	CS-1002	600
250	G.E. TEBB, 2300 V	K	1800
250	G.E. S.B. Open	KT	1800
250	F.M. S.B. Open	H	1800
250	G.E. S.B. Open 2200 v	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E.T.E.F.C.BB.	K6329	3600
200	G.E. S.B. Drip	K-6326	3600
200	F.M. B.B. Open	H-207	1800
200	G.E. TEBB	K	1800
200	A.C. S.B. Open	ARW-626	1800
200	G.E. S.B. Open	KT-558	1800
200	Cont. T.E.F.C. B.B.		1800
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-15S	1200
200	G.E. S.B. Open	KT-562	1200
200	G.E. S.B. Open 2200V	IK	1200
200	G.E. S.B. Open	IK	900
200	Cont. T.E.F.C.B.B.	NP686C	1800
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	G.E. TEBB	K	1800
150	West S.B. Open 2200V	CS	1800
150	G.E. S.B. Open	IK	1800
150	Wst. S.S.B Opn CS-761C		1800
150	West. S.S.B. 2200V Open	CS-772C	1200
150	G.E. S.B. Open KT-558		900
150	Cont. T.E.F.C. B.B. New		900
150	G.E. B.B. Open KT-558		900
150	G.E. S.B. Open	IK	720
125	G.E. TEFCBB	K	3600
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Drip	K-505	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open	CS-716C	1800
125	G.E. S.B. Open KT-553		1200
125	G.E. S.B. Open	IK	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	A.C. S.B. Open AR-505S		3600
100	G.E. S.B. Open KT-343		1800
100	A.C. S.B. Open 2200 V	ARX	1800
100	G.E. S.B. Open KT-347		1200
100	West. SSB Open CS-607		1200
100	West. SSB Open	CS	1200
100	A.C. SB Open 2200 Volt	ARX	1800
100	G.E. S.B. Open	IK	900
100	G.E. S.B. Open KT-356		900
100	G.E. S.B. Open	IK	720
75	West. T.E.F.C. B.B. New CS-754C		1200
60	Wagner T.E.F.C.B.B. New CP-504		1200
60	Wagner T.E.F.C.B.B. New CP-505		900
50	Wagner T.E.F.C.B.B. New CP-445		1200
40	L.A. T.E.F.C.B.B. XP EX-405		1800

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1500 HP D.C. MOTORS

1500 HP—525 volts D.C.—600 R.P.M.—NEW—2-bearing continuous duty motors—manufactured by Westinghouse. In original crates. From Navy Destroyer Escort. SPECIFICATIONS: 2-bearing 1500 HP—525 volts DC—2270 amps—600 RPM—ambient temperature 40C—class B insulation—2-bearing pedestal sleeve type—shunt wound—efficiency 94.23%. ONLY 6 AVAILABLE—BUY NOW AND SAVE. Suitable for steel mill drive—offshore oil rigs—rolling mill drive—dredge pump applications.

1200 KW GENERATORS

(2) Equal to new—manufactured by Allis-Chalmers. 1200 KW—525 volts D.C.—2290 amps 750 RPM—cooling self-ventilated—totally enclosed—separate excitation—continuous duty—class B insulation—mfg type M.H.C.—frog leg armature.

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DIESEL-ELECTRIC GENERATOR

G.M.C. 900 H.P., 650 RPM; G.E. Generator; G.E. Exciter (DC); 4 G.E. air cooled radiators; Panel Control Board Condition excellent. Discontinued from service.

R. S. BADER & CO.
142 Broadway, Denver 3, Colo. PEarl 3-1187

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
1	3000	G.E.	OATU-D (oil)	3	69000/34500/4160/2400
2	3000	Mal	TCR	3	7200/6600-4160/2400
2	750	G.E.	K	1	4600-120/240
1	750	G.E.	HT	3	4150Y-208/416
1	600	West.	Power Ctr.	3	2400-120/240/480
3	500	West.	SL		4800/2400-240/480
1	300	West.	Power Ctr.	3	2400/4160Y/120-240-480
1	300	Penna.	(Askarel)	3	12470Y/7200-240
2	250	G.E.	H Pyranol	1	4800/8320Y/120-240
2	250	West.		1	2300/4600-220/460
3	200	G.E.	H	1	7800-15600-220/440
1	150	Eisler	OA	1	4160-240/480
3	100	West.	(Air) VR	1	480/240-240/120
3	100	G.E.	H		2400/4160-240/480
3	50	G.E.	HS	1	2400/4160/240/120
1	50	Amer.	Abestol	3	4160-120/208Y
5	50	G.E.	HS	1	2400/4160-240/480
3	3.75	West.	(Air) VR	1	480/240-240/120
3	3.75	West.	S	1	2400/4160Y/120/240
4	25	West.	Hypersil	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
3	60	E.M.	1200	125	220 v. Syn.
2	100	West.	1200	250	2300/4150Y Syn.
1	150	Cr. Wh.	600	125	220/440
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	300	G.E.	1200	250	440 Sync.
1	1000	West.	720	600	2300/4160Y

ENGINE GENERATOR SETS

1—Int. Harv Diesel UD-18 62.5 KVA G.E. 3/60/220—1000 r.p.m.
1—Hercules Gas HXE 62.5 KVA Westghse 3/60/480—1200 r.p.m.
1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 3/120—2200 r.p.m. NEW.

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	690	CW	220/440
1	60	G.E.	1800	MT	220
1	75	G.E.	600	IM	440
2	100	West.	1800	T.E.F.C. B.B.	220
1	150	G.E. Triclad	1175	M	220/440
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	450	MT	2200

"FOR POWER"
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N.J.
PHONE NEW YORK—LONGACRE 5-3727
PHONE NEW JERSEY—UNION 5-2600

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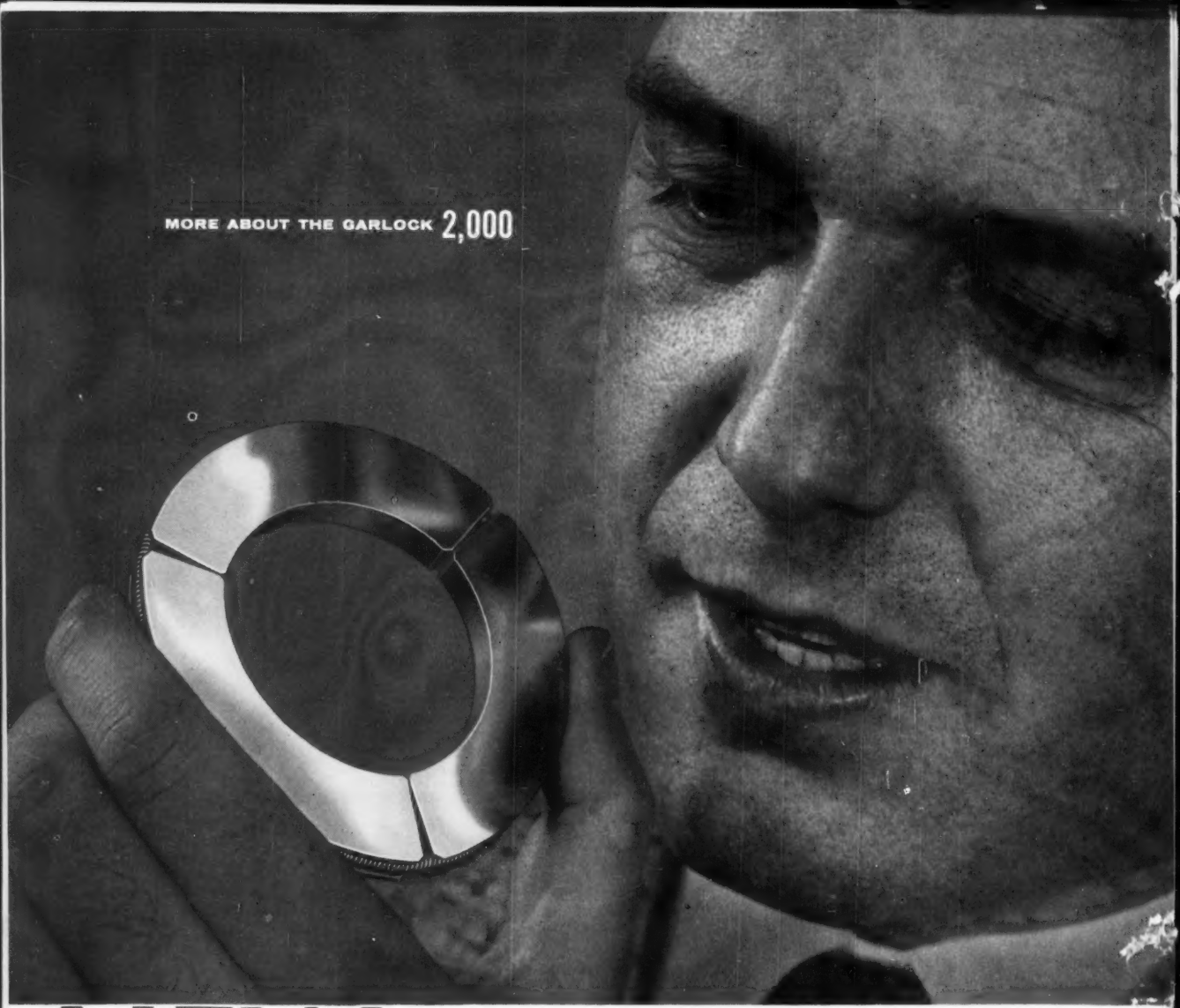

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...provides positive sealing at no extra cost

Now all Garlock Metal Scraper and Packing Rings have a surface finish of 10 micro-inches or less! And flatness of the rings is measurable in light bands; which means a more positive seal between ring and groove. This exclusive Garlock advantage has been made possible through improved manufacturing technique and is offered to you without additional cost.

Garlock Metal Packings with the exclusive "Mirror-Finish" are another part of the famous "Garlock 2,000" . . . two thousand styles of packings, gaskets, and seals for every need. The only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for Metal Packings Folder 3888-9.

Floating Metal Packing Sets are designed for use on reciprocating rods of air and gas compressors, steam and gas engines. Available in either solid cup or split-case design. Solid cup design (illustrated at right) withstands pressures to 30,000 psi.

Garlock Metal Packing Rings of graphitic cast iron, bronze, carbon, bakelite and babbit are precision made to exact specifications of size and finish assuring maximum efficiency.

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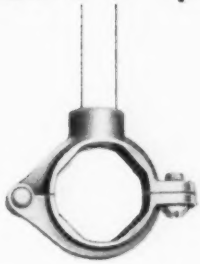
Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

RUGGED STRENGTH... LESS WEIGHT

Grinnell *MALLEABLE IRON* Pipe Hangers



The fluidity of molten white iron allows casting of malleable pipe hangers in any desired form. Such hangers, designed in a manner consistent with the best malleable practice, are cast so closely to dimensions that subsequent shaping is not required.

Controlled annealing in the most modern equipment is employed to produce hangers having uniform internal grain structure, superiority ductility, high strength and freedom from casting strains. Quality controls in our foundries — such as hourly checks of metal, daily photomicrographs of metallurgical structure, tensile tests of sample bars from each melt — insure the rugged, lightweight strength of Grinnell malleable iron pipe hangers.

This start-to-finish manufacture by Grinnell assures malleable iron pipe hangers with a minimum safety factor of 5 or more, based on the ultimate tensile strength of the material.

The A.S.A. Code permits the use of malleable iron pipe clamps, embracing the pipe, when the temperature of the pipe does not exceed 450°F. When it does exceed this temperature, malleable iron may still be used in beam clamps, hanger flanges and the like if the malleable part is 12 inches or more distant from the pipe.

Testing metal structure with photomicrograph

Every Grinnell Malleable Iron Pipe Hanger offers . . .

- Safety Factor of at least 5
- Thickness of metal increased at points of concentrated stress
- Homogeneous metal composition throughout
- Extremely high resistance to impact and corrosion
- Economy
- Heat resistance up to 450°F

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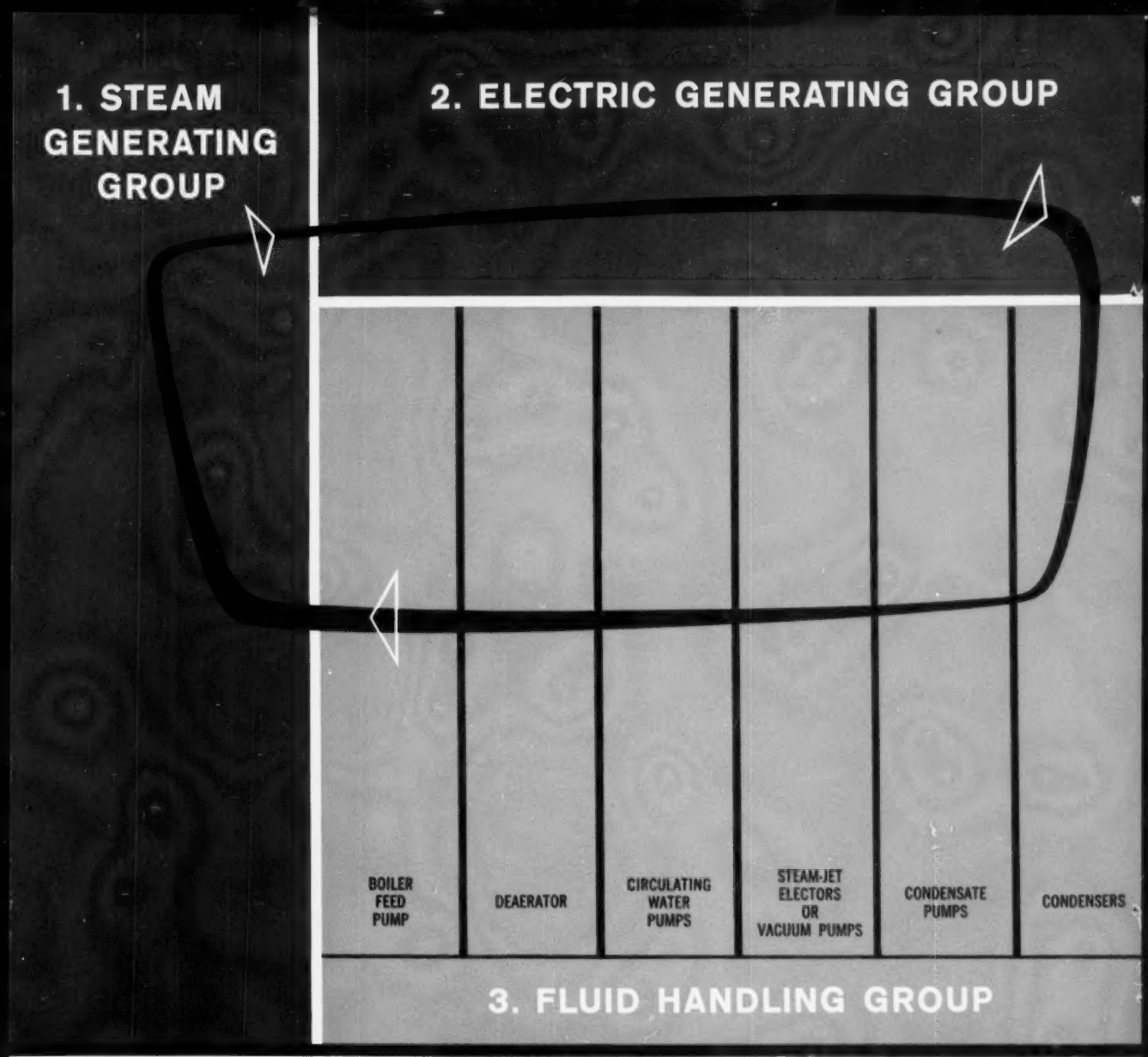
AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island — **Coast-to-Coast Network of Branch Warehouses and Distributors**

Manufacturer of: pipe fittings • welding fittings • forged steel flanges • steel nipples • engineered pipe hangers and supports Thermolier unit heaters • Grinnell-Saunders diaphragm valves • prefabricated piping • Grinnell automatic fire protection systems



LOOK AT ALL THREE FOR POWER

THE FLUID HANDLING GROUP in a steam power plant has as many individual components as the other two combined. Failure of any one component can disrupt operation of the whole. Reliability can best be achieved through compatible integration of the wide range of equipment in this all-important group. As a manufacturer of all major fluid handling components, Worthington's "system-wise" experience and knowledge can be of extreme value to you. For information, write or call your nearest Worthington district office. Worthington Corporation, Harrison, New Jersey.

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